SCIENTIFIC AMERICAN SUPPLEMENT No. 104

Scientific American Supplement, Vol. IV, No. 104.
Scientific American, established 1845.

NEW YORK, DECEMBER 29, 1877.

Scientific American Supplement, $5 a year.
Scientific American and Supplement, $7 a year.

PENDULUM PUMP.

THE engravings below illustrate a very curious donkey pump invented and manufactured by Mr. Joseph Stannah, Southwark Bridge Road, London. The steam and water pistons are fixed on the same rod, and the action is therefore direct. A rotary movement is employed to work the valves and limit the length of the pistons. The remarkable feature about the pump lies in the means adopted for causing the rotation of two fly-wheels, no dog link or connecting rod being employed. If our readers will think the matter over, they will see that if a crank shaft were allowed to move sideways in slots carrying its bearings, the crank pin might be attached direct to a piston rod, and rotation could be given to the crank. In the pendulum pump the two fly-wheels are mounted on pins set in the ends of two hanging links, as shown in the sectional view, while a crank pin common to both fly-wheels passes through a suitable bearing in the piston rod. When the pump is at work the fly-wheels oscillate backwards and forwards while revolving, the motion being very moderate in range.

One of the links works a slide valve in a way which will be readily understood by examining the detailed views of the valve, which we give. The whole arrangement is very cheap and simple, and works very well.—*Engineer.*

CORROSION IN BOILERS.

THERE exists in France a Commission whose special duty it is to look after boilers, and to try and find out the causes of accidents. A few weeks since a report was made to this Commission by M. Hanet-Clery, a mining engineer-in-chief, on the corrosion of steam-boilers by the action of sulphuric acid. The Commission had its attention drawn to the explosion of two steam-boilers, one at a colliery in the Nièvre, the other at the Ougrée Ironworks, in Belgium, and which were attributed to the destructive effect on the metal in consequence of the presence of sulphuric acid in deposits left by the smoke on certain parts of the sides of the boiler. Other facts, or supposed facts of like import appeared, and the subject was brought before the scientific and industrial world in the *Annales des Mines et des Ponts et Chaussées*, the problem being whether, under given conditions, the sulphurous acid of the smoke was turned into sulphuric acid, and the report of M. Hanet-Clery is one of the results.

As regards the two accidents already referred to :—

1. The one which happened at the colliery occurred under the following circumstances: the boiler which burst was cylindrical, the fire being placed exactly beneath, and a superheated, from the cylindrical boiler by a brick arch, which nearly touched the upper part of the superheater. The latter was torn wide open in front, to the right of the strip which covered a longitudinal joint of two plates of iron, and then perpendicularly to the end on both sides.

The thickness of the iron at the part which gave way first had originally been 12 millimeters, or half an inch nearly, but it had been reduced to 1·7 millimeter, and consequently totally incapable of supporting the pressure of six kilogrammes, under which the boiler worked. The destruction of the iron was all on the exterior, and extended—though not equally—over the upper end on the side exposed. The mischief had all occurred in five years.

M. Douvillé, a mining engineer, attributed it to the corrosive action of oxygen and sulphurous acid, contained in the products of combustion in the presence of water coming from a fissure in the boiler above, which, having traversed the brick vaulting, fell on the reheater, wetting the upper part, which was relatively cold, being situated at the extremity of the circuit of smoke, and close to the point where the feed-water arrived, and he remarked that the water vapor contained in the smoke was liable to condense there, and the effect of this condensation might be added to that of the infiltration, and favor the oxidation of the sulphurous acid into sulphuric acid; the water from the boiler concentrating itself chiefly along the edge of the cover-plate over the joint of the two plates, which prevented it descending. It would thus moisten the deposits in this part, which the form of the brickwork prevented being regularly cleaned, and thus favored oxidation of the sulphurous acid in sulphuric acid on the surface of the metal. M. Douvillé found large scales of oxide of iron on the corroded parts, and also sulphur in some form of combination.

2. The accident at the Ougrée works presented more conclusive evidence; in this case, sulphuric acid was actually found in a free state, as well as in the form of sulphate of iron. The following are the circumstances of this case. The boiler was horizontal and cylindrical, with two water tubes below, and it was heated by the flames of the puddling furnaces. These flames at once enveloped one of the tubes and half the lower part of the boiler itself, and, making the circuit, heated the other half and second tube. The tube to the right of which the flames debouched was torn open in much the same manner as the superheater in the former case. The fracture, taking two courses perpendicularly, are in the iron plate itself, the other along a riveted seam. The thickness of the iron was reduced to about one millimeter (one twenty-fifth of an inch), at the edges of the first rent. The corrosion was all exterior.

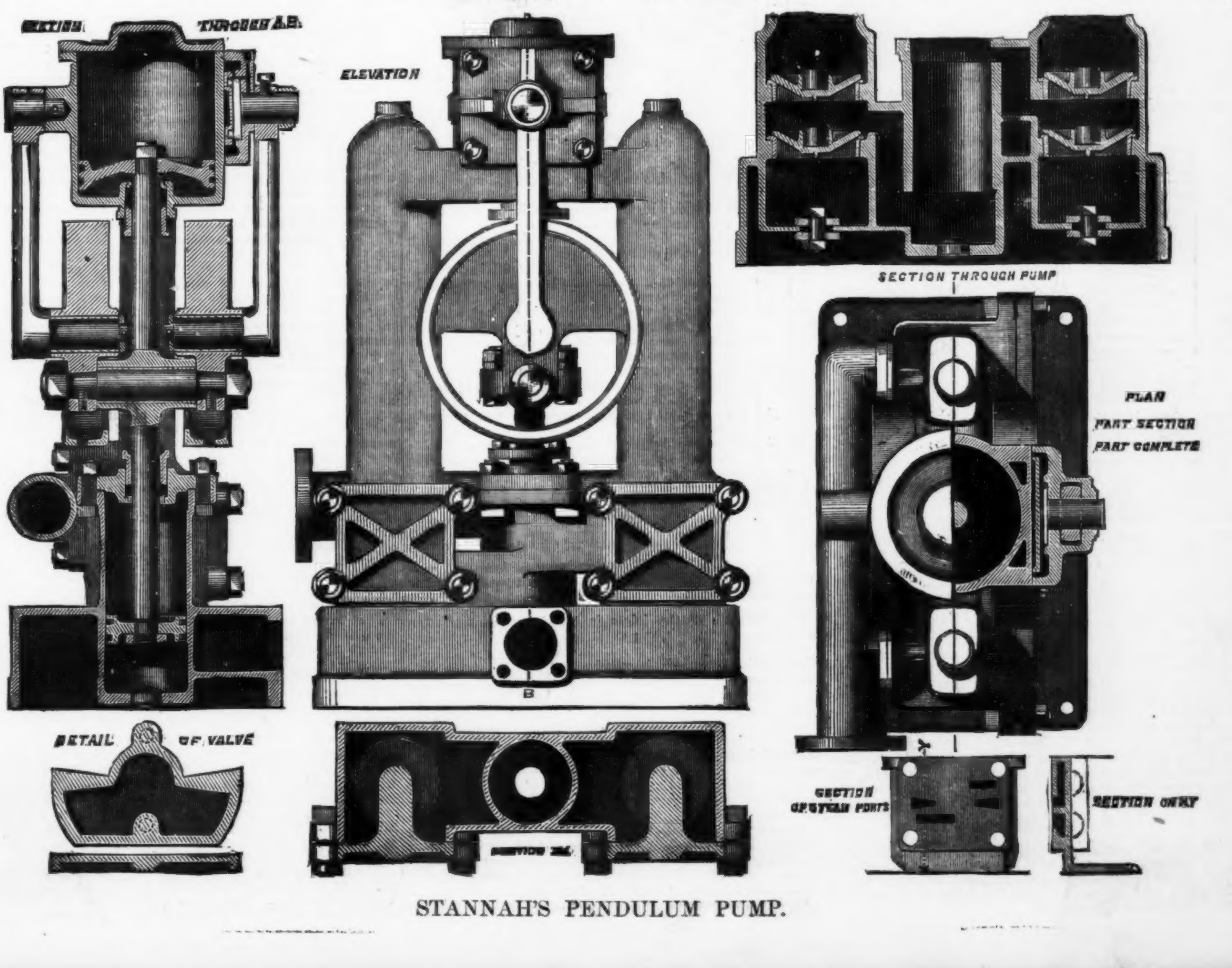
Two samples of the soot, etc., left by the smoke in the parts destroyed were analyzed; they gave sulphate of iron between 52 and 53 per cent., and free sulphuric acid in one sample 1·42, and the other nearly 12 per cent. Soot from other parts also contained sulphuric acid, but not enough to have any sensible result on the iron.

The action is thus explained: the soot, etc., is deposited during the working of the puddling furnaces in an entirely dry state, but when the fires are put out, the air, loaded with humidity, enters and converts the soot into a paste; the oxidation of the sulphurous acid then occurs, and the iron is in the best condition to be attacked. The corrosive action is thus going on all the time the boiler is not in work, in parts that could not be cleaned out, while no such action occurred where the soot had been cleared away.

3. Examples of exterior corrosion by condensation of steam suspended in the smoke on the colder portions of boilers were pointed out by M. Mennier Dollfus some years since, and published; one of these cases was observed at the works of M. Charles Kestner, at Thaun.

The works contained two cylindrical boilers with three tubes, and between them, in the same brickwork, six reheaters arranged in pairs on three stages. The flames circulated under the three tubes, twice around the boiler itself, and then in the three stages of the reheater from above downwards. The feed-water traversed in the opposite direction. Generally only one of these boilers was used at a time, working night and day, but less actively at night.

In an experiment, when the feed-water arrives at a temperature of 20° C., the water of the first reheater below only marked 30° C on issuing, and that of the third reheater at 50° C. On the other hand, the temperature of the smoke and gases at the issue of the third reheater did not exceed 150° in the day and 100° at night. At the end of two years' working under the above conditions, the reheaters were already attacked, and at the end of six years, although the iron was of excellent quality, they were so reduced that they



STANNAH'S PENDULUM PUMP.

had to be replaced. The corrosion took place on the colder portions of the reheaters, and it was found that the first cause was the sulphurous acids contained in the condensed steam deposited by the smoke, and in the presence of air and of these acid waters, oxidation of the iron readily occurred, with the subsequent production of sulphate of iron.

4. Observations have also been made on this cause of destruction of boilers, by M. Cornut, Engineer of the AssocitION of the Proprietors of Steam Apparatus of the North of France, at Lille. He often observed exterior corrosions, which he attributed to the action of smoke, and which he found absolutely confined to those parts of the iron which were wetted by infiltration or accident.

5. Resuming the facts stated above, the transformation of sulphurous into sulphuric acid, under the action of water, or steam and air, in presence of a metal is not new. This property of sulphurous acid has even been employed practically in treating certain minerals, and in purifying the neighborhood of certain metallurgical establishments. We may mention as a notable instance, the process of M. Lamine for the manufacture of sulphate of alumina at Ampain, in Belgium, and the treatment of certain oxides of copper on the banks of the Rhine. Such applications as these, not of recent date, should have awakened engineers to the possibility of the destruction of the iron boilers by a like action, but such was not the case, and it remains to be noted that if the fact is now well known, the subject requires to be most carefully studied in all its details, some of which cannot fail to be of practical importance.

Conclusion.—The whole may be summed up as follows :—In the matters deposited on the plates of boilers at a certain distance from the fire, and which are rendered humid by any accidental cause, the sulphurous acid carried forward by the combustible gases attack the iron by the formation of sulphate of iron.

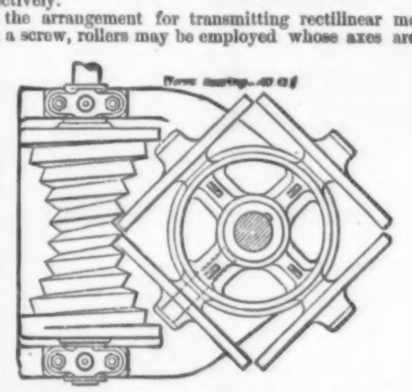
The attack may occur while the boiler is heated through an escape of water from the boiler itself by infiltration through the brickwork, or by the condensation of steam in the flames and smoke in contact with iron plate relatively cold. It may also occur when the boiler is not in use by means of the penetration of the air into the flues.

The diverse origin of the corrosive action points out the nature of the precautions to be taken to obviate the destruction, except as applies to the condensation of the vapors, on which subject many arrangements have been recommended, bnt have not yet obtained the sanction of experience. The precautions alluded to above are only such as should be taken in ordinary practice for the preservation of apparatus, that is to say careful design and construction and systematic and complete cleansing.

HAWKINS'S WORM GEARING,

THE object of this ingenious mechanical device is to transmit motion by means of screw or worm gearing, either by a screw, in which the threads are of equal diameter throughout its length, or by a spiral worm, in which the threads are not of equal diameter throughout, but increase in diameter each way from the centre of its length, or about the centre of its length outwardly. Parallel screws are most applicable to this device when rectilinear motions are produced from circular motions of the driver, and spiral worms are applied when a circular motion is given by the driver, and imparted to the driven wheel. The threads of a spiral worm instead of gearing into teeth like those of an ordinary worm-wheel, actuate a series of rollers turning upon studs, which studs are attached to a wheel whose axis is not parallel to that of the worm, but placed at a suitable inclination thereto. When motion is given to the worm then rotation is produced in the roller wheel at a rate proportionable to the pitch of worm and diameter of wheel respectively.

In the arrangement for transmitting rectilinear motion from a screw, rollers may be employed whose axes are in-



clined to the axis of the driving screw, or else at right angles to or parallel to the same. When separate rollers are employed with inclined axes or axes at right angles with that of the main driving screw each thread in gear touches a roller at one part only; but when the rollers are employed with axes parallel to that of the driving screw a succession of grooves are turned in these rollers, into which the threads of the driving screw will be in gear throughout the entire length of the roller. These grooves may be separate and apart from each other, or else form a screw whose pitch is equal to that of the driving screw or some multiple thereof.

The annexed engraving shows an arrangement for transmitting circular motion in either direction. It is a plan in which the spiral worm is made of such a length that the edge of one roller does not cease contact until the edge of the next comes into contact; a wheel carries four rollers which turn on studs, the latter being secured by cottars; the axis of the worm is at right angles with that of the wheel. The edges of the rollers come near together, leaving sufficient space for the thread of the worm to fit between any two contiguous rollers. The pitch line of the screw thread forms an arc of a circle, whose centre coincides with that of the wheel, therefore the thread will always bear fairly against the rollers and maintain rolling contact therewith during the whole of the time each roller is in gear, and by turning the screw in either direction the wheel will rotate.—*Engineering.*

THE inclined surfaces of the wedge used in splitting should be slightly concave, as it is less liable to rebound in frosty timber than one with plain surface. It is said that a ring beetle, with the end less than five inches in diameter, is better than one of a larger size.

BOILER INSPECTION.

RULES OF THE ENGLISH BOARD OF TRADE.

INSTRUCTIONS TO SURVEYORS.

Working Pressure for Cylindrical Shells of Boilers.

THE Board of Trade have been frequently asked to publish all the details of the rules on which their advisers act in recommending the amount of pressure for steam boilers. They have therefore in this Circular put the whole together for the information of engineers and boiler makers.

When cylindrical boilers are made of the best material, with *all* the rivet holes drilled in place and *all* the seams fitted with double butt straps each of at least five-eighths the thickness of the plates they cover, and *all* the seams at least double riveted with rivets have an allowance of not more than 50 per cent. over the single shear, and provided that the boilers have been open to inspection during the *whole* period of construction, then 6 may be used as the factor of safety. But the boilers must be tested by hydraulic pressure to twice the working pressure in the presence and to the satisfaction of the Board's Surveyors.

But when the above conditions are not complied with, the additions in the following scale *must* be added to the factor 6 according to the circumstances of each case.

A	.15	To be added when all the holes are fair and good in the longitudinal seams, but drilled out of place after bending.
B	.3	To be added when all the holes are fair and good in the longitudinal seams, but drilled out of place before bending.
C	.3	To be added when all the holes are fair and good in the longitudinal seams, but punched after bending instead of drilled.
D	.5	To be added when all the holes are fair and good in the longitudinal seams, but punched before bending.
E*	.75	To be added when all the holes are not fair and good in the longitudinal seams.
F	.1	To be added when the holes are all fair and good in their circumferential seams, but drilled out of place after bending.
G	.15	To be added if the holes are fair and good in the circumferential seams, but drilled before bending.
H	.15	To be added if the holes are fair and good in the circumferential seams, but punched after bending.
I	.2	To be added if the holes are fair and good in the circumferential seams, but punched before bending.
J*	.2	To be added if the holes are not fair and good in the circumferential seams.
K	.2	To be added if double butt straps are not fitted to the longitudinal seams and the said seams are lap and double riveted.
L	.1	To be added if double butt straps are not fitted to the longitudinal seams and the said seams are lap and treble riveted.
M	.3	To be added if only single butt straps are fitted to the longitudinal seams and the said seams are double riveted.
N	.15	To be added if only single butt straps are fitted to the longitudinal seams and the said seams are treble riveted.
O	.1	To be added when any description of joint in the longitudinal seams is single riveted.
P	1.	To be added if the circumferential seams are fitted with single butt straps and are double riveted.
Q	.2	To be added if the circumferential seams are fitted with single butt straps and are single riveted
R	.1	To be added if the circumferential seams are fitted with double butt straps and are single riveted.
S	.1	To be added if the circumferential seams are lap joints and are double riveted.
T	.2	To be added if the circumferential seams are lap joints and are single riveted.
U	.25	To be added when the circumferential seams are lap and the streaks of plates are not entirely under or over.
V	.3	To be added when the boiler is of such a length as to fire from both ends, or is of unusual length, such as flue boilers, and the circumferential seams are fitted as described opposite P, R, and S; but, of course, when the circumferential seams are as described opposite Q and T, V ·3 will become V ·4.
W*	.4	To be added if the seams are not properly crossed.
X*	.4	To be added when the iron is in any way doubtful, and the Surveyor is not satisfied that it is of the best quality.
Y	1.65	To be added if the boiler is not open to inspection during the whole period of its construction.

Where marked * the allowances may be increased still further if the workmanship or material is very doubtful or very unsatisfactory.

The strength of the joints is found by the following method—

$$\frac{(\text{Pitch}-\text{Diameter of rivets}) \times 100}{\text{Pitch}} = \left\{\begin{array}{l}\text{Percentage of strength}\\ \text{of plate at joint as}\\ \text{compared with the}\\ \text{solid plate.}\end{array}\right.$$

$$\frac{(\text{Area of rivets} \times \text{No. of rows of rivets}) \times 100}{\text{Pitch} \times \text{thickness of plate}} = \left\{\begin{array}{l}\text{Percentage}\\ \text{of strength}\\ \text{of rivets as}\\ \text{compared}\\ \text{with the}\\ \text{solid plate}\dagger\end{array}\right.$$

Then take iron as equal to 23 tons and use the smallest of the two percentages as the strength of the joint, and adopt the factor of safety as found from the scale given in this circular—

$$\frac{(51520 \times \text{percentage of strength of joint}) \times \text{twice the thickness of the plate in inches}}{\text{Inside diameter of the boiler inches} \times \text{factor of safety}} = \left\{\begin{array}{l}\text{Pressure}\\ \text{to be al-}\\ \text{lowed}\\ \text{per}\\ \text{square}\\ \text{inch on}\\ \text{the safe-}\\ \text{ty valves}\end{array}\right.$$

Plates that are drilled in place *must* be taken apart and the burr taken off, and the holes slightly countersunk from the outsides.

Butt straps *must* be cut from plates (and *not* from bars) and must be of as good a quality as the shell plates, and for the longitudinal seams *must* be cut across the fibre. The rivet holes may be punched or drilled when the plates are punched or drilled out of place, but when drilled in place must be taken apart and the burr taken off, and slightly countersunk from the outside.

When single butt straps are used and the rivet holes in them punched they *must* be one-eighth thicker than the plates they cover.

The diameter of the rivets *must* not be less than the thickness of the plates of which the shell is made, but it will be found when the plates are thin or when lap joints or single butt straps are adopted that the diameter of the rivets should be in excess of the thickness of the plates.

THOMAS GRAY.

† If the rivets are exposed to double shear, multiply the percentage as found by 1·5.

A NEW LOOM HARNESS.

SOME four years ago Mr. John H. Crowell, Mechanical Superintendent of the Kendrick Loom Harness Company, a company largely engaged in the manufacture of weavers' harnesses in Providence, submitted to the directors of the company a harness devised and constructed by him upon a principle entirely original. Its superiority over other known forms was manifest, but as it was made by hand, it was not regarded with much favor by the board generally, it being evidently too expensive in construction to compete with harnesses made by machinery. The inventor was very confident of his ability to construct a machine which would make the new harness by power, and as he had displayed at various times, much talent as a mechanician, it was decided to allow him to make the attempt. After a year's unremitting labor, a machine was produced that would manufacture the harness desired, and which gave such promise of success that it was deemed advisable to proceed with the manufacture of a sufficient number of machines to give the process a thorough trial.

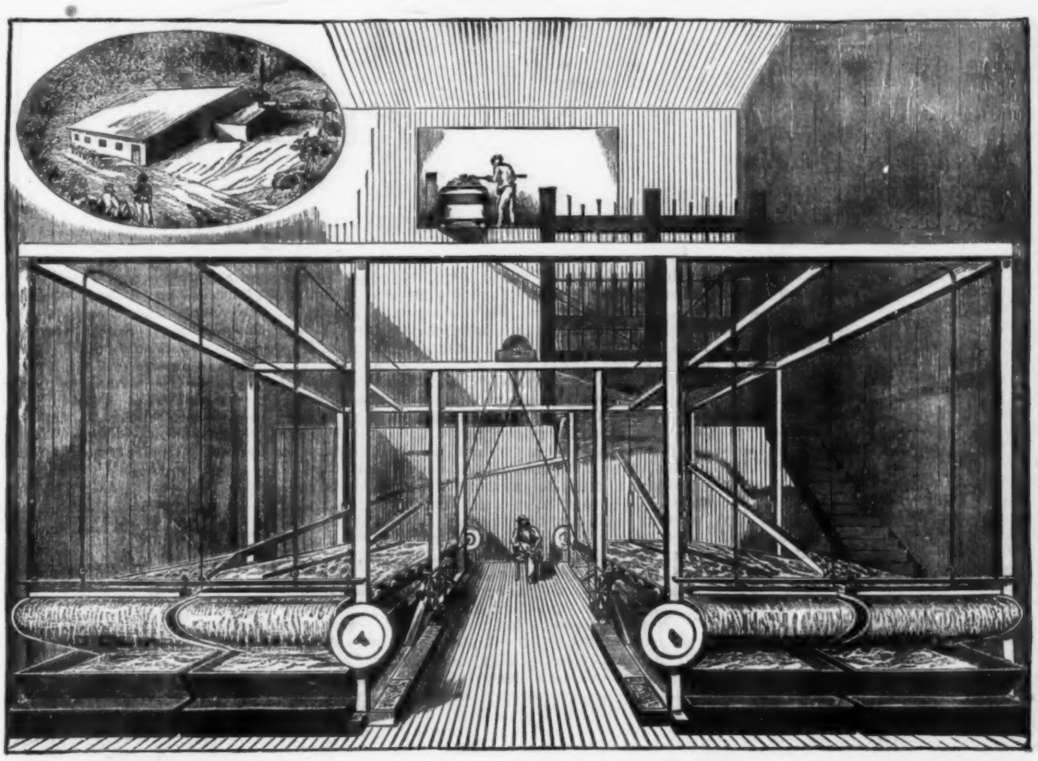
An arrangement was made with the Lanphear Machine Company, well known manufacturers of cotton machinery, at Phenix, to build a specified number of machines. This labor proved to be one of the most difficult and protracted character. Such exactness was required that it was found necessary to apply a greater degree of skill and care than had ever been applied to the manufacture of mill machinery, some of the work being as delicate as that required for the construction of watches. Special tools, magnifying glasses and Vernier gages measuring the one thousandth part of an inch were employed in making some of the cutters, formers and dies that come in contact with the metal that is formed about the heddle twines. After a year's expenditure of skilled labor, a number of machines were finished and the inventor began the manufacture of harnesses. As in the case of most all really valuable inventions, new complications now presented themselves. It was found impossible to realize in practice some of the aims of the designer, which were correct in theory, and the first harnesses when put to work failed to meet the approval of manufacturers. After another wearisome delay and modification of the eye, the difficulties were overcome, and the machine entered upon its regular satisfactory work.

Years of labor have been wasted in the effort to make a perfect harness. The principal forms now in use are the twine harnesses known as the single knot or loop and the double knot. These forms were used as long ago as when looms were operated by hand, no practical improvement having been made in the form of the harness, though improvements have been made in the method of finishing with varnish, and in their construction by automatic machinery. The loop harness has the advantage of being cheaply constructed, but is by no means a perfect mechanism. The eyes are liable to become twisted out of shape and varied in length, so that there is a constant chafing, both of the warp and of the harness. They cannot be relied upon for equal durability, some of them giving out unexpectedly after a brief use, and others wearing a much longer time. The main disadvantage in this is not so much in the cost of the harness as in the poor work done on the loom before the harnesses are adjudged sufficiently worn to justify their renewal, and the incessant attention which it is necessary to bestow upon them. The double knot harness differs from the single knot only in the form or construction of the eye—having two knots instead of a knot and a loop, and are considered by manufacturers to be more durable. The two forms, however, agree in the tendency to jostle and chafe the warp at every beat; and as they are constructed entirely of twine, that part of the eye which comes most frequently in contact with the warp, and lifts or depresses it, is sooner or later cut off, the eye is destroyed, and the harness unfitted for further use, before the other parts are much affected. The Crowell metallic knot harness seems to be absolutely and thoroughly scientific. It is more pliable, is not subject to disarrangement in handling or usage; it always presents the eye uniformly to the warp, and never has twisted eyes. In fact, it is impossible for the machine to construct eyes of this sort, for the twines are laid straight from the top to the bottom of the harness, and are only intersected by the metallic knots that are clasped about them. It reduces the abrasion between the threads of the warp to a minimum, as is proved by the diminished quantity of lint under the loom; and the eye, which is soon destroyed in the twine harness, is in this harness practically indestructible. Up to this time none of them have given out, though some of them have been put to work as an experiment, without even varnishing, weaving 3,500 yards of cloth without any indication of wear on the harness. Experience has demonstrated that the same weaver with the same loom, and the same warp and filling, can weave one yard per loom per day of medium goods more than withthe common harness. Users of the harness concede that the fabric woven by the Crowell metallic knot harness is of a more uniform excellence, and that those serious blemishes called "pick-outs" are extremely rare.

The machine itself is a great curiosity, and deserves to be placed on exhibition for the public gratification. It is automatic in operation. The twine and the metal are delivered to it continuously from spools and reels. The metal, which

is prepared with great care by machinery, is fed through two delicate grooves by an ingenious mechanism; it is then cut off the proper length by elfin shears, which, with the combined action of a set of delicate frames and dies operating vertically and horizontally, shape the pieces of metal into the required form for the reception of the twine, after which operation the metal is closed upon it and finishes the eye. Thus the machine continues its operation until the completion of the harness. Several thousand sets of these harnesses are already at work, some mills being filled with them and producing goods of all grades, both in quantity and quality highly satisfactory to the parties using them. It is believed that the metal knot harness as now made is to come into general use, but any modification or change in form of metal or shape of eye which may be demanded by further experience can be accomplished by this ingenious machine. Although it has not been fully demonstrated yet by the lapse of time, the manufacturers of this harness confidently believe that it will prove durable beyond all others, even in an unvarnished state. Should this prove to be the case, a most important improvement in weaving has been discovered, and the inventor has builded even better than he knew. For it is manifest that a pliable harness must be infinitely better for the warp than one made stiff and rigid by successive coats of varnish. Should this secondary and unexpected advantage be secured, it will not be the first time that an invention has shown an incidental result of more value than the one aimed at.—*Providence Journal.*

THE FRUE VANNING ORE CONCENTRATOR.



THE FRUE VANNING MACHINE OR ORE CONCENTRATOR.

THIS machine is now very generally known, at least by name, in the various mining districts of the United States; and during the past twelve months has been introduced pretty largely into some few sections. The machine has already been described somewhat in detail, in our SUPPLEMENT. The present paper, which is from the *Engineering and Mining Journal*, is merely intended to touch upon the work already accomplished, and in so doing indicate the class of work for which in future the vanner is likely to be generally adopted. It may be well, however, to state again, in a few words, the principle of working.

The dressing surface consists of a flanged rubber belt, slowly revolving against the descending stream of sand and water, and receiving a continuous lateral vibratory or shaking motion, which keeps the whole volume of water and sand in gentle movement. This side motion of the belt, the vanning, is the important feature of the machine; and, in connection with the perfect surface of the rubber belt itself, is the real element of the success of the vanner on fine slimes. The Brunton belt in England, and the Hoffman in Germany, are known as slime dressers; the first is merely a self discharging inclined plane in principle; the last, receiving in addition a succession of blows, is an improvement on the former, being an intermediate stage between it and the present vanning machine. The difficulty of making the belts last in the Hoffman machine was, according to the statement of the well-known manufacturing firm at Kalk, near Cologne, the reason of the belt dropping out of use. In the vanner no such difficulty occurs; the belt is of long duration, the only appreciable wear being caused by the attrition of particles of ore passing over its surface with the water; and this wear, which is slight, is remedied by the occasional application of a liquid rubber paint. That the lateral motion is in itself preferable to percussion few practical dressers will deny.

There are two forms of vanners in use; the single and the double. The first is a belt 27 feet 6 inches long and 4 feet wide, supported either in bearings or on toggles, within a stout wooden frame; both the side motion and revolving of the belt being run from a single pulley on the crank-shaft. In the second form two belts are placed side by side, their supporting frames being bolted together and slung from above by iron rods; and both belts receiving motion from the same crank shaft and driving drum. The belts are in this case generally 33 feet 6 inches long by 4 feet wide. In the accompanying engravings the arrangement of the double machines is shown from a sketch by our artist, Gen. F. L. Vinton, of the Everitt & Company's Mill on Four-Mile Creek, Boulder County, Colorado.

In the mill above-mentioned, the machinery consists of a 25 horse-power engine, Blake's crusher, two Tulloch's automatic stamp feeders, 10 stamps, and two double vanners, *i. e.*, 4 machines, fed from a classifier below stamps. This mill, as also seven others fitted with the vanners in Boulder County, is for the concentration of the low grades of tellurium ore. The average capacity of the mill is from 13 to 15 tons in 24 hours. The ore treated has varied in value from $10 to $100 per ton; where it carries tellurides and is worth $20 or $25 per ton, it pays well for freighting to the mill and for concentration. The average value of concentrations produced has been about $2,000 per month from actual sales to smelters. The value of the concentrations per ton varies, of course, with the value of the original ore, and percentage of base minerals (mostly iron pyrites), some being as low as $50, others running up to $900 per ton. From the water tanks in which the collected mineral is deposited by the revolving belt, there is a gentle overflow of water into long settling boxes, in which settles the finely divided mineral suspended in the water. This "float mineral," as it is called, when working on regular tellurium ores, amounts to about one lb. per ton of ore treated, and is worth from $1 to $3 per lb. Assays made on "tailings" or waste from the tables vary from $2 to $4.40 per ton. Five men, including two engineers, run the mill day and night; with water power three hands would be sufficient. In Boulder County there are now 28 machines either at work or in course of erection; not including two lately destroyed by the burning of Carvell's Mill.

It may probably excite the surprise of those acquainted with the usual systems of concentration elsewhere in use to hear of an ore being stamped to a fine grain, run direct over a single machine, and then allowed to flow off as waste; but a little consideration of the character of tellurium ores will show the necessities of the case. In the low grade ores there is a fine impregnation of iron pyrites throughout most of the gangue, with intermixed fine patches and minute particles of the tellurides. A coarse crushing on such a rock is almost useless, for the mineral is not thereby separated from the particles of rock. The various tellurides of gold and silver, by reason of their state of divisions and brittleness, are not easy minerals to concentrate; but they can be and are saved by proper care. A higher percentage than most of the mills attain could undoubtedly be saved, by the use of a second machine to treat the tailings of the first; and, considering the nature of the ore, and the usual systems of dressing in use, no one would consider the use of two machines under a battery of stamps, as a reflection on their effectiveness as concentrators. The millmen, however, seem satisfied with single machines; and the miners who really have anything in their ores send them down regularly to the mills for treatment. One mine in this way sells concentrates of the value of $1,000 per month from ore previously worthless.

At Nederland, Boulder County, eight of the vanners are being put in place to treat the gold ores of the district after passing over the usual copper plates below stamps: the loss of gold from using plates alone being very high.

In the San Juan district five machines are at work; three being in Crooke's work at Lake City, treating the "dust" refuse from Krom dry concentrators.

At the Silver King mine, in Arizona, silver ore from $100 to $30 per ton has been worked. The first vanner put in for trial yielded in 40 days' running of 24 hours, 22 tons of concentrates assaying $1,600 per ton, and working up to 90 per cent. of the assay value. This is an exceptionally fine ore to treat, and three more vanners are now being put in place. The ore is, in this case also, stamped directly on to the machine.

The black auriferous sea sands of Oregon have lately been worked with marked success. In the first experiment at San Francisco, one ton only of the sand was treated, assaying $8.27 per ton in gold. The concentrations yielded $1,935.47 per ton, the tailings showing only a trace on assay. The concentrate, though high compared with the original ore, was diluted with particles of sand passing over in the final cleaning up of the belt on so short a run; but in steady work much higher concentrates are produced. Seven machines were put up in Oregon as a commencement; and on the first run, after everything was in good working order, 320 tons of black sand put over six machines in six days yielded 3,400 lb. of concentrate. This concentrate was redressed and reduced to 100 lb. worth $6 per pound. It was then amalgamated and run into gold bar. The sand treated in this run was of a poor quality, purposely worked and served to show how low a grade could be made to pay. Since the sand has merely to be shoveled into cars and dumped into automatic feeders, and each vanner will treat from 10 to 12 tons in 24 hours, it will be seen at once how small a cost per ton is the treatment.

At Sulphur Banks, in California, six machines have been at work for over a year, concentrating the poor ores of cinnabar to a product ready for retorting into quicksilver.

Ores of gray copper and purple copper, disseminated through a limestone gangue, have been treated at the Liberty mine, Maryland; in one run, the original ore carried 2 per cent copper, the concentrate 58 per cent, and the tailings 0·2 per cent; on a second trial, ore carrying 2·3 per cent copper gave a concentrate of 60·4 per cent, and tailings showed only 0·09 per cent.

At Mine la Motte, Missouri, one of the vanning machines is in use for working the lead slimes made in crushing for the jigs.

The first actual mill of vanners ever erected was that at the Silver Islet mine, Lake Superior. Here twenty machines in double row take the pulp from fifty stamps, working regularly sixty tons per day; while four machines re-dress the concentrate from the lower vanners to make it of equal value with that from the first row of machines. Silver ore carrying only $8 per ton pays well for running in this mill; as, owing to the presence of native silver and but little base mineral, the concentrated ore runs very high. This mill is now idle for want of ore, the mine being very lightly worked; but it paid for cost of construction in a few months' running.

In the Marmora gold district of Canada the gold-bearing arsenical pyrites is concentrated by the vanner, and the product shipped to Germany; the arsenic paying the shipping expenses.

There are also in Idaho, Nevada, and California, several machines from which no results have yet been made public. In Cornwall very excellent results were obtained in working various classes of tin ore; but, owing to the depressed condition of tin mining at present, and the difficulty in getting mine owners there to put capital into any change of machinery, that country has been neglected for the time being; although it can be demonstrated clearly that, in the presence of the competition from which Cornwall is now suffering, its future salvation consists in increased production of metal by labor-saving appliances.

In the treatment of the black iron sand of Oregon, the full effect and capability of the side shake in the vanning machine is most strikingly shown. Here is a coarse and heavy iron sand carrying minute spangles of free gold. The vibration of the belt affects strongly the coarser particles of sand, keeping them in quick motion, and therefore lightly suspended in the down-flowing water, while the fine flakes of gold sift down through the moving mass and, once touching the surface of the belt, are no more influenced either by the motion of the latter nor by the descent of water, but are carried up slowly by the moving bed and deposited clean in the collecting tank below. It is a generally accepted maxim in concentration, that the more uniform the size of particles in the matter treated, the better the separation effected. But a man skilled in the use of a vanning shovel—not a gold pan, which has a flange, will save cleanly nearly the whole of a mineral slime from an intermixture of quite coarse particles of rock. This is done by so regulating the motion of the shovel, as to take advantage of the greater influence exerted by the moving water on the coarse pieces of rock than on the fine mineral clinging to the shovel's face. In fact, the flow of water regulated in this manner will move coarse particles of mineral almost as freely as coarse particles of gangue, still leaving the finely divided mineral undisturbed on its bed; it is fully as much a question of surface exposed

by the respective particles as of their specific gravity. This is the reason why the vanning machine has been able to save such fine mineral, from an admixture with comparatively coarse gangue; the side motion multiplying the effect of the flowing water on the coarser material, assisting the settling of the mineral to the belt, and yet not disturbing it when once settled. In certain classes of work, especially where quantity is an object, it seems even preferable to have rather coarse sand go over the belt with the "slimes," say, for instance, all that will pass a screen of forty holes to the lineal inch; the sand in this case forming a sort of bed, which, while tending to check the speed of the downflowing water, is not allowed to become so heavy as to interfere with the perfect settling of the fine mineral. Of the quantity which a single belt is capable of working, exact figures can only be given for particular ores. As already stated, with the black iron sands one vanner can treat as much as twelve tons in twenty-four hours; but there are some impalpable slimes on which two tons in twenty-four hours would be fair work, owing to the volume they occupy. In a number of cases five and six tons in a day is the usual work.

The modern German dressing works are wonderfully complete, and very effective on heavy mineral ores, but are not adapted to such ores as carry but finely disseminated mineral; and it is in the treatment of this latter class, and with jigs as auxiliary for the coarse ore, that the vanning machine is now coming into such prominence.—*Engineering and Mining Journal.*

METALS ACCOMPANYING IRON.

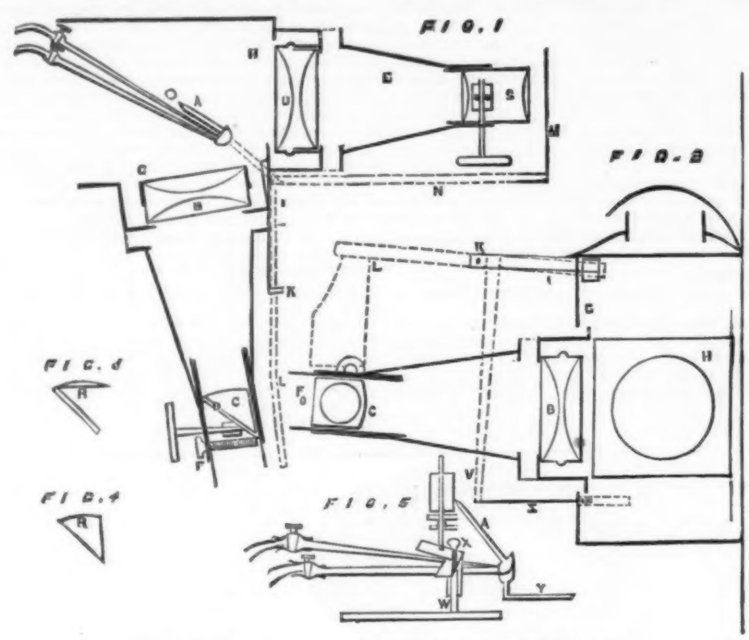
By A. TERREIL.

The numerous analyses made during several years of the principal ores of iron and of the metallurgic products, have convinced the author that iron, like platinum, is almost always accompanied in its ores by several metals, which are found in the metallurgic products of this metal. These metals are manganese, nickel, cobalt and chromium, principally magnetic metals, whose presence has been considered as characteristic of meteoric irons, and also copper, vanadium, titanium, and tungsten, whose presence is accidental. The author uses the following method to detect these metals. After having treated the substance in the ordinary way, either with aqua regia, or by hydrochloric acid and chlorate of potash, the solution is filtered and washed with distilled water. The filtrate is then poured gradually, with stirring, into ammonia, and the precipitate thrown on a filter, and washed with distilled water. The metals are at this point of the analysis divided into the following groups:—1. Metals found in the residue insoluble in acids: *titanium* and *tungsten*. 2. Metals precipitated along with the oxide of iron: *chromium* and *vanadium*. 3. Metals dissolved in the ammoniacal liquor: *copper*, *nickel*, *cobalt* and *manganese*. From the residue the tungstic acid may be dissolved out by ammonia, and the titanic acid by concentrated and boiling sulphuric acid. The presence of titanium is indicated by the violet coloration of the liquid on the addition of zinc, while that of tungsten is shown by the greenish-yellow powder, easily characterized by the blowpipe. When there is too little titanic acid in solution, it is of course best to evaporate to dryness, and examine with the blowpipe. The chromium and vanadium are detected by suspending the precipitate of oxide of iron in a solution of pure potash, heated up to 90°. Permanganate of potassium is then added, as long as the latter is decolorized. The permanganate transforms chromium and vanadium into chromate and vanadate of potassium. The solution, after complete transformation (when it assumes a green color), is filtered; the alkaline liquor saturated with acetic acid and filtered; and to a portion of the filtrate are added a few drops of acetate of lead. Chromate of lead is thereby produced, which may be mixed with vanadate. Vanadium is detected in the other portion of the liquor by adding a solution of tannin recently prepared. The vanadic acid then slowly forms with the tannin a blue-black precipitate, although the liquid is immediately colored. When the yellow precipitate of lead chromate contains vanadate of lead, it is likewise colored black-blue, or greenish-black, when it is moistened with the solution of tannin. The metals of the last group are detected by adding to the ammoniacal liquor a few pieces of pure potash, which throws down the metals as oxide. The precipitate is collected on a filter, washed, and a small portion of it tested for manganese by nitre and potash. The copper is separated from the hydrochloric acid solution of the precipitate by sulphuretted hydrogen, and the filtrate, after boiling and concentrating, is treated with ammonia, which shows the presence of nickel by its assuming the blue-violet tint. The cobalt is detected in the following manner:—The ammoniacal solution is treated with a few drops of permanganate of potassium, which peroxidises the cobalt and precipitates the manganese. The mixture is filtered, supersaturated with hydrochloric acid, and left at rest for 24 hours, after addition of a little alcohol. A violet-rose precipitate of roseo-cobaltic hydrochloride will be obtained if cobalt be present. In conclusion, the author states that the proportions of metals accompanying iron are ordinarily very slight in the metallurgic products, whilst in the native or meteoric irons these proportions often reach 10 per cent.

THE NEWTONIAN DISSOLVING LANTERN.

An improvement in dissolving view lanterns has been recently patented by Mr. H. Keevil, of Bath, and has, we believe, been introduced to the public under the name of the Newtonian lantern. The object of the invention is to obtain the optical effects of dissolving scenes by using only one light, burner, or jet, and one lantern, instead of as hitherto by using two lights and lanterns.

The method by which the effect is produced is shown in the drawings where, in Fig. 1, a lantern of either metal or wood is shown in horizontal section. A prismatic lens, the sectional form of which is shown at C, having its diagonal surface, D, silvered, or a plane right-angled prism of glass having a lens or lenses fitted to it for the adjustment and focussing of the pictures placed in the stage, is focussed by means of the nut of the pinion and rack, and is so placed as to carry on the rays of light passing through the condensing lenses properly placed as shown at B, to take the light emanating from a burner, A, for that purpose. A modification of the above, producing the same optical effects, may be constructed by using a plane glass silvered speculum or metallic speculum, with adjusting lenses adapted for focussing the scenes, as shown at Fig. 4. In either case the invention consists in placing the arrangement above named within the converging rays of light after passing through the condensers from the burner, as shown at C, and before they cross at a focal point, so as to intercept those rays and turn them in a direction nearly at right angles, in order to make the light cover and occupy the same place on the disc as that from the usual direct through or front optical arrangement shown at E, the complete adjustment being accomplished by an adjusting screw and spring connected with the frame of the prismatic lens, as shown at F. The above described optical arrangement (which the patentee claims as his invention) or adaptation, when used in connection with any of the usual well-known levers and shutters hitherto in use, will produce the effects known as dissolving scenes from one light, and by the use of only one lantern. In order to produce the best effects, he recommends that the side of the lantern, G, to which the prismatic arrangement is attached be bent inward to an angle of about 9° with the front, as



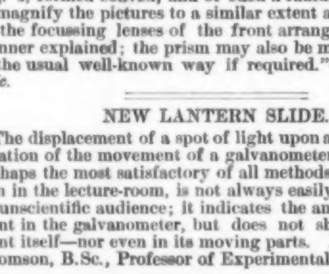
IMPROVED DISSOLVING LANTERN.

shown in the drawing at H, and in order to produce the dissolving effects by the above optical arrangement, he affixes the lever, I, at any convenient place to move on a point at K, the position of the lever and shutters being shown by the dotted lines. A shutter is fixed at the end of the arm, I, to work and cover the rays of light emanating from the prismatic lens at C, and another shutter, M, is placed at the end of the arm, N, to work and cover the rays of light emanating from the direct through optical arrangement at E, and by working the lever either up or down, the desired effects can be produced. And when the light used for the purpose is that known as the lime-light or oxycalcium light, then in order to produce a uniform intensity of light all over each circle or disc, the burner, A, and the lime swing on a centre, W, or pivot, such pivot having a screw above it at X, Fig. 5, for adjusting the height of the light, and by connecting an arm, Y, of the burner, A, with the rod, Z, and with the levers shown at V, Fig. 2 (a vertical section), the same is made to turn or face alternately opposite to the condensers B, or U, as may in turn be required.

As the invention discloses features of some commercial value, we give the claim of the patentee in his own words:—"First. The arrangement, combination, and application of a prismatic convex lens, or a plane right-angled glass prism, or plane silvered glass, or metal speculum with lenses adapted to either modification in the manner described and illustrated, so as to intercept and turn the rays of light passing through and from the condensing lenses, and to render the one light or burner available for producing the effects on a disc known as dissolving scenes. And, secondly, by arranging the burner carrying the lime for producing the light to turn or swing on a pivot, so as to cause the flame alternately to face each pair of condensers as may in turn be required; the meaning I attach to the words prismatic lens is that of a glass right-angled prism having one of its surfaces, R, Fig. 3, formed convex, and of such a radius as will cause it to magnify the pictures to a similar extent as that produced by the focussing lenses of the front arrangement S, in the manner explained; the prism may also be made achromatic in the usual well-known way if required."—*English Mechanic.*

NEW LANTERN SLIDE.

The displacement of a spot of light upon a screen as an indication of the movement of a galvanometer needle, though perhaps the most satisfactory of all methods for demonstration in the lecture-room, is not always easily understood by an unscientific audience; it indicates the amount of movement in the galvanometer, but does not show the instrument itself—nor even in its moving parts. Mr. Silvanus P. Thomson, B.Sc., Professor of Experimental Physics in Uni-



versity College, Bristol, has designed an exceedingly simple instrument which meets the requirements of a good lecture-room galvanometer in a remarkable degree. The instrument, of which we annex an illustration, is in the form of a magic lantern slide, and is employed in the same way for casting an image or shadow on the screen. It consists of a coil of insulated copper wire wound upon a flat bobbin of brass A B C D, within which is delicately balanced, upon a horizontal axis E, a magnetic bar or needle N S, which carries a long index of aluminum fixed at right angles to it, and which traverses a semicircular divided arc or scale reduced by means of photography upon a plate of glass. All the parts of the instrument are kept within the thickness of the mahogany slides so that it can be used in any magic lantern and magnified to any size upon the screen.

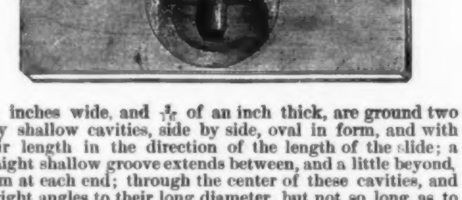
In order to obtain a maximum of sensitiveness, the axis of the needle is placed very slightly above the centre of gravity of the needle with its index. With a magnetic needle balanced so nearly at its centre of gravity, it might be supposed that when the plane of the instrument happens to lie in or near to the plane of the magnetic meridian, the indications of the instrument would be invalidated by the effect of the magnetic "inclination" or "dip;" but Mr. Thomson corrects this by a compensating magnet placed below, but at such a distance as to neutralize the influence of the vertical intensity of the earth's magnetism without impairing the sensitiveness of the instrument as a galvanometer.

For experiments with the thermopile and for detecting currents capable of overcoming but small resistance, when the bobbin is wound with a few turns of thick wire, but where a circuit is required of greater length and resistance, the coil is composed of a great many turns of fine wire, the ends of which are connected to the terminal screws seen to the left of the frame.—*Engineering.*

HOLMAN'S LIFE SLIDE FOR THE MICROSCOPE.

IN the use of the microscope in that branch of science called biology, it is often desirable to keep under view small organisms, such as bacteria and vibriones, for hours, and even for days and weeks at a time. Hitherto this has not been possible, for lack of a proper contrivance; the animals would soon die from the exhaustion of oxygen in the confined space, and they were not in that normal condition necessary for satisfactory study during the time that they did live.

Below is pictured what is known as Holman's Life Slide, which obviates this difficulty. The construction of this accessory to the microscope may be described as follows: In one center of one face of a strip of glass 3 inches long,



$1\frac{1}{16}$ inches wide, and $\frac{3}{16}$ of an inch thick, are ground two very shallow cavities, side by side, oval in form, and with their length in the direction of the length of the slide; a straight shallow groove extends between, and a little beyond, them at each end; through the center of these cavities, and at right angles to their long diameter, but not so long as to reach their sides, a cavity is ground as deep as the thickness of the glass will permit.

The cavities and groove thus described occupy a circular surface of the slide about $\frac{3}{4}$ of an inch in diameter, which is covered, when in use, with a circular piece of microscopic glass 1 inch in diameter.

The philosophy of its action may be thus described: Into the deep cavity, as a reservoir, is put the material in which are the organisms to be examined; the cover is then put on, and the fluid on the surface of the plate wiped away. The pressure of the atmosphere holds the thin cover firmly to the plate, and the fluid between the cover and the plate commences to evaporate at the edges, its place being supplied by more fluid from the reservoir. As the evaporation proceeds, the cover is bent downwards by the atmospheric pressure, and meets a resistance at the juncture of the groove with the edge of the shallow cavities, resulting in the edges of the cover rising at each end of the long groove, and a small bubble of air finds its way through the groove to the reservoir. This automatic action thus furnishes a continual supply of fresh air, and the life of the little animals is sustained during the time necessary to observe the changes that take place in them during their life history. When the smaller forms are inclosed in one of these life slides, to get access to the air they seek the edges of the cover, and range themselves in a zone, at a short distance from its rim, close to where the air comes in contact with the water. Being thus situated, in accordance with the law that compels them to take up these positions, they can be viewed with the highest powers of the microscope, and their true nature and habits much better studied than by the old methods.—*Journal of the Franklin Institute.*

LESSONS IN MECHANICAL DRAWING.

By PROF. C. W. MACCORD.

Second Series.—No. XVII.

On the Screw Propeller.—Continued.

BEFORE illustrating by a practical example the use of the screw with radially expanding pitch, we will explain one or two of the subordinate problems involved in the construction, which can be done to better advantage by separate diagrams, while thus the main drawing will not be confused by a great number of construction lines.

The first of these relates to the intersection of the acting face with the hub. If the latter be cylindrical, this intersection will, as we have already seen, be a true helix. But it is more frequently the case that the hub is made of an ellipsoidal form, or something like it, which, of course, modifies the curve in question. In Fig. 111, $e\,c\,f$ is the outline of the hub; the central element $o\,c$, of the surface, being vertical, appears in the end view as $o'c'$. Now, $e\,w$, the half length of the hub, is a known fraction of the pitch at the distance $C\,c'$ from the axis; therefore setting off $c'\,d'$, the same fraction of the circumference, we draw $C\,d'$; this will be the position in the end view of an element containing the point d', which, in revolving, will rise to e'; and since it describes a circle, seen edgewise in the side view, we project d' to d, on the vertical line through e, thus locating one point on the curve of intersection. Otherwise, $e\,w$, parallel to the axis, is the outline of a cylinder, on which lies a true helix of known pitch, also belonging to the screw surface, which is cut at d' by the vertical plane through e.

Next, if with any radius $C\,o'$ we describe a circle in the end view, it may be regarded as the base of a cylinder whose outline in the side view is $o\,r$. The pitch at this distance, $C\,o'$, from the axis being also known, we set off $o\,r$, the same fraction of it that $e\,w$ is of the smaller pitch before used: then $r\,e$ is the side view of the element seen as $C\,d'\,x$ in the end view, after being revolved into the plane of the paper, that is, so that x shall go to o'. Subdivide $o\,r$ and $e\,w$ into equal parts at 1, 2, and $o'\,x$ into the same number of equal parts at $y\,z$; then 1-1, 2-2, will represent the elements $C\,z$, $C\,y$, also revolved into the plane of the paper. Now 2-2 cuts the outline of the hub, $e\,c\,f$, in m, which is projected to m', revolved to b', and counterprojected to b on the vertical through m. Because m is the highest revolved position of the point on the surface whose distance from the axis is $m\,l$, and true position on the radius $c\,y$ in the end view; which, in revolving, describes a circle whose plane is perpendicular to the axis, and consequently is seen edgewise in the side view. In a similar manner we find the position of the point in which the element 1-1 pierces the ellipsoid; and by repeating the process we find as many points as we wish.

It will be observed that the principle of this operation is identical with that described in the preceding lesson, in determining the effect upon the blade of rounding off the corner of the space within which it was required to turn.

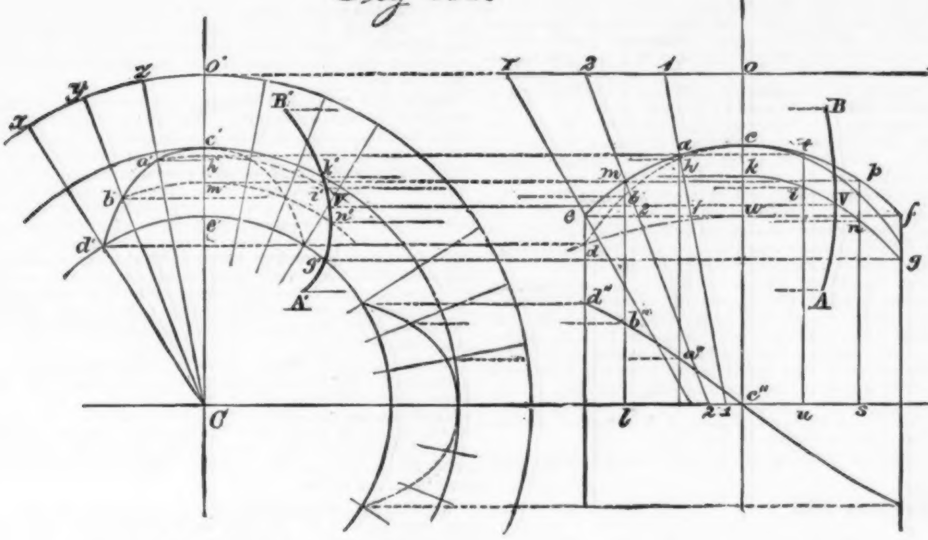
In fact it is but a special application of the general principles previously illustrated in many forms, in finding the intersections of surfaces. A particular reason for giving this case by itself, is to call attention to the fact that, by selecting the definite length, $e\,w$, and first drawing the element through e, we fix the point d, one limit of the required line. Any elements would have given us points on this line, but it is desirable to locate this one with special accuracy. By revolving the points a', b', d', through any angle in the end view, and projecting them after revolution to the same vertical lines in the side view, we may determine the appearance of this intersection in other positions: thus, in the figure $c''\,a''\,b''\,d''$ shows it when revolved through 90°; in other words it is a top view of the same curve, as in previous diagrams.

The same mode of operation, evidently, may be employed in determining the intersection of this screw surface with any surface of revolution having the same axis. But it may not be the most eligible one under all circumstances; an instance in point is the very common practical case in which an overhang is given to the blade, and, as in some of the preceding instances, the space within which the screw is to turn is terminated, not by a plane perpendicular to the axis, but by a cone, of which the meridian outline is a line inclined to the axis. Now, the elements of the screw may cut the elements of this cone at quite acute angles; this does not vitiate the principle of the above method, but it may make it advantageous to adopt some other mode of operation, instead of depending upon these acute intersections, which we have already done in more than one instance. This intersection is one of the most important lines in the drawing, since in the end view it limits the part of the disc, or entire circle of the rim, which is occupied by the acting face; hence it ought to be determined with greater care than need be taken with such curves, for instance, as those by which the corners are rounded off.

Now, in Fig. 112, let $C\,C$ be the axis, $k\,k$ the outlines of the cylinder on which the outer helix lies, $l\,l$ that of a cylindrical hub, and $y\,z$ that of a concentric cone, cutting $l\,l$ at u and $m\,m$ at z. What we have to do is with the edge of the blade between the hub and the rim; that is to say, in our diagram, the intersection of the screw surface with the part of the cone generated by the revolution about $C\,C$ of the definite right line $u\,z$. In order to find this, we must know what part of this peculiar surface is cut by the cone; and in this case we shall assume that $u\,x$ is the element through the poin u on the hub; also let this element lie in the plane of the paper, so that in the end view it shall appear as $u'x'$. Then, $x\,z$ being a known fraction of the pitch of the outer helix, set off $x'\,z'$, the same fraction of the outer circumference, and draw $C\,z'$; this will be the true position in the end view of an element which, if revolved into the plane of the paper, will pass through z in the side view. Set off $u\,v$, the same fraction of the pitch of the inner helix that $x\,z$ is of the outer, and $v\,z$ will be the element thus revolved. Subdivide $x\,z$ and $u\,v$ into the same number of equal parts at a, b, and c, d; then $a\,c$ and $b\,d$ will represent elements revolved into the plane of the paper, whose true positions in the end view are $c'\,a'$, $d'\,b'$, radii subdividing the angle $x'\,C\,z'$ into equal parts. These elements, $a\,c$, $b\,d$, cut $u\,z$ at e and g; draw $e\,f$, $g\,h$, and $z\,r$ perpendicular to the axis; then set off $c'\,e' = e\,f$, and $d'\,g' = g\,h$, and the curve $u'\,e'\,g'\,z'$ will be the end view of the intersection sought. Project e' to s on $e\,f$, g' to t on $g\,h$, also z, to w on $z\,r$, and the curve $u\,s\,t\,w$ will be the side view of the intersection.

In order to calculate the values of $e\,f$ and $g\,h$, we will, as before, let $x\,z = \mathrm{P}$, $u\,v = \mathrm{p}$, and suppose each to be divided

Fig. 111.



LESSONS IN MECHANICAL DRAWING.—SECOND SERIES.—No. 17.

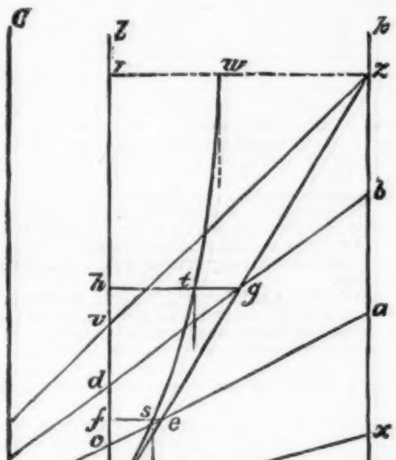


Fig. 112.

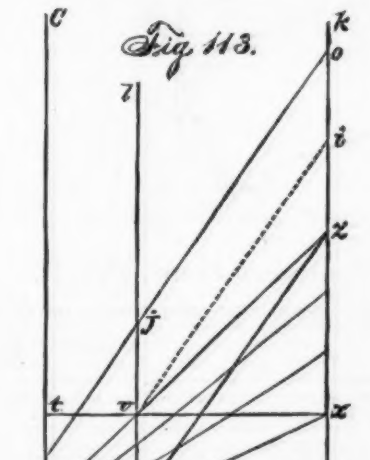
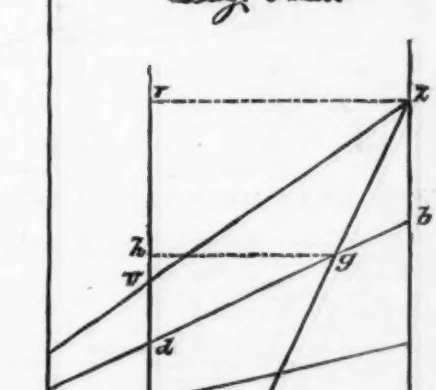


Fig. 113.

Fig. 114.



LESSONS IN MECHANICAL DRAWING.—SECOND SERIES.—No. 17.

into n parts. Then from the similar triangles $e\,u\,e$, $a\,s\,e$, we have

$$ue : ez :: uc : az,$$
$$\therefore\ ue : ue + ez :: uc : uc + az,$$
$$\text{or } ue : uz :: uc : uc + az.$$

But from similar triangles $u\,f\,e$, $u\,r\,z$, we have

$$ue : uz :: ef : rz,$$
$$\therefore\ ef : rz :: uc : uc + az$$

whence $\dfrac{ef}{rz} = \dfrac{uc}{uc + az}$

But $uc = \dfrac{p}{n}$, and $ax = \dfrac{P}{n}$, whence $az = P - \dfrac{P}{n}$

therefore $\dfrac{ef}{rz} = \dfrac{\frac{p}{n}}{P - \frac{P}{n} + \frac{p}{n}} = \dfrac{\frac{p}{n}}{\frac{P(n-1)+p}{n}} = \dfrac{p}{P(n-1)+p}$

But the ratio of P to p being known, we may write $P = mp$, which gives $\dfrac{ef}{rz} = \dfrac{p}{mp(n-1)+p} = \dfrac{1}{m(n-1)+1}$

In a similar manner we will find $\dfrac{gh}{rz} = \dfrac{2}{m(n-2)+2}$; and in general, whatever the number of equidistant radii introduced between x' and s', we shall find the distances to be successively measured on them outwardly from the inner circle, to be fractions of $r\,z$ or its equal $u'\,x'$, forming the series

$$\frac{1}{m(n-1)+1},\ \frac{2}{m(n-2)+2},\ \frac{3}{m(n-3)+3},\ \frac{4}{m(n-4)+4},\ \text{etc.}$$

This series, it will be noted, is of precisely the form as that previously deduced in the case of the intersection of this surface by a plane; which leads to the conclusion that under conditions, the same screw surface may be cut by a concentric cone, and by a plane perpendicular to the axis, with the result that the two spirals seen in the end vies will be identical in form, but in opposite directions.

This state of things is illustrated in Fig. 113; $l\,l$ is the outline of the inner cylinder, $k\,k$ that of the outer one, $y\,z$ that of the cone, which cuts $l\,l$ in u. The element of the

Now, if the element of the screw surface travel beyond the position $v\,s$ in the side view, it will evidently intersect $y\,s$ produced; and successive positions will be represented in the end view by setting off beyond s' other arcs equal to $a'\,b'$, and drawing the radii thus located. And their lengths may be determined by continuing the above series, which will give

$$\frac{4}{2(3-4)+4} = \frac{4}{2} \text{ of } u'\,x'$$
$$\frac{5}{2(3-5)+5} = \frac{5}{1} \quad \text{"} \quad \text{"}$$
$$\frac{6}{2(3-6)+6} = \frac{6}{0} = \text{infinity}$$

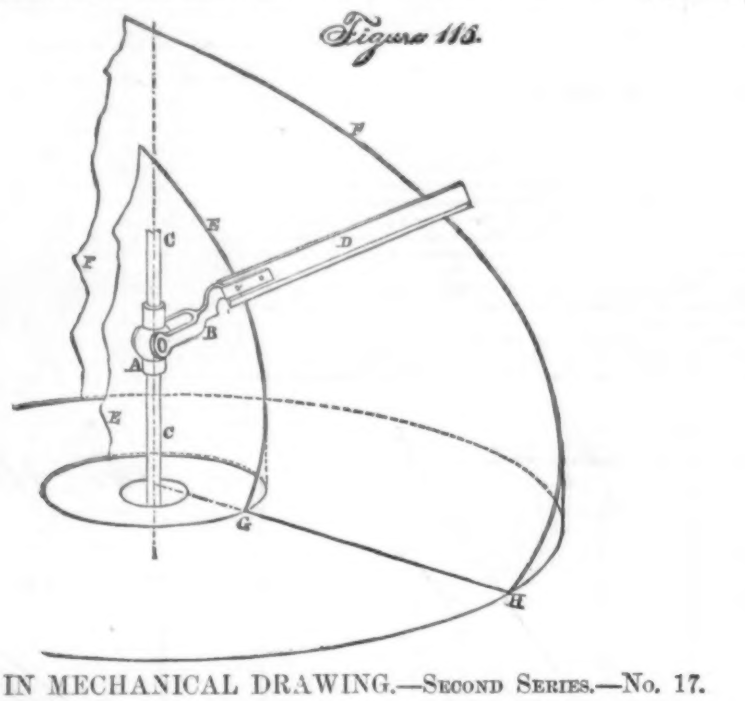
This last result will be understood by the aid of Fig. 113, where it is evident that, the angle between the element of the surface and that of the cone diminishing as the former travels in the direction $u\,v$, they will become parallel eventually, as shown at $j\,v$, which is parallel to $y\,s$. How far beyond v the element must travel in order to become parallel to $y\,z$, may be thus determined: drawing $v\,i$ parallel to $y\,z$, we observe that the distance $z\,i$ is equal to $v\,u$ or p. Now, while u is going to v, x goes to z, gaining upon x a distance $P - p$; and in order to attain the condition of parallelism alluded to, there is still to be gained the distance $z\,i$ or p; before which can be done, u must advance beyond v, through a distance which will be to $u\,v$, as p is to $P - p$, or, since $P = m\,p$, as 1 is to $m - 1$.

Since in the present instance $m = 2$, we have $m - 1 = 1$, and $v\,j$ is therefore equal to $u\,v$; which agrees with the result previously obtained by continuing the series.

In the case of the plane $v\,x$ in Fig. 113, we reach the same value, infinity; which obviously means that the element becomes perpendicular to the axis, that is, parallel to the plane. And drawing $u\,q$ perpendicular to $C\,C$, we find $x\,q = p$, the distance which a has still to gain upon v, before this will occur, the travel being in the opposite direction; from which, by similar reasoning, we shall find in the present case $u\,s = v\,u$, and when u reaches s, the element will lie in the central plane $L\,M$, which is identical with that similarly lettered in Fig. 108.

We may also extend the series below zero, by giving nega-

Figure 115.



LESSONS IN MECHANICAL DRAWING.—SECOND SERIES.—No. 17.

screw surface through u is $u\,x$, which cuts $k\,k$ in x; through the latter point draw $x\,t$ perpendicular to $C\,C$ the axis, cutting $l\,l$ in v; then, drawing $v\,z$, that line may represent the element of the screw surface in a new position, $u\,v$ and $x\,z$ being equal fractions of the inner and outer pitches. In the end view, therefore, $u'\,x'$, $v'\,z'$, the true positions of these elements, will appear as two radii; the intersection of the screw surface with the cone will be the spiral $u'\,z'$, and that with the plane $v\,x$ will be the equal and opposite spiral $v'\,x'$.

We have thus far considered only the parts of these spirals intercepted between the inner and outer cylinders; which for practical purposes is, indeed, sufficient; still, it might be sometimes desirable to determine points beyond those limits, for the purpose of fixing with greater exactness the directions and curvatures at and near the limits. This might be done by assuming a smaller and a larger cylinder than those actually to be used, determining in the manner above described, the spirals intercepted between them for the purposes of construction, and making use of only the parts required in the drawing of the blade. But if the lengths of the radiants of the spiral have been calculated between two circles, and it is afterward found necessary to extend the curve beyond those limits, this may be done by drawing other equidistant radii, and finding their lengths by continuing the series.

For example, in Fig. 112, where $u\,e$ is one half of $x\,z$, and each is divided into three parts, we have in the formula $m = 2$, $n = 3$. The distance to be set off from u' on $C\,x'$ in the end view is zero; and on the radii $C\,a'$, $C\,b'$, $C\,v'$, we find by the series

$$c'\,d' = \frac{1}{2(3-1)+1} = \frac{1}{5} \text{ of } u'\,x'$$
$$d'\,g' = \frac{2}{2(3-2)+2} = \frac{2}{4} \quad \text{"} \quad \text{"}$$
$$g'\,x' = \frac{3}{2(3-3)+3} = \frac{3}{3} \quad \text{"} \quad \text{"}$$

tive values to the numerals in the formula, so that the terms will read

$$\frac{1}{m(n+1)-1},\quad \frac{2}{m(n+2)-2},\quad \frac{3}{m(n+3)-3},\ \text{etc.}$$

but as the points are closer together, the nearer we approach the center, it is less likely that this will be necessary, and it is not worth our while to discuss the special results due to that mode of proceeding.

In Figs. 112 and 113, however, it will be observed that the portion $u\,s$ of the element of the cone concerned in constructing the intersection between the limits of the inner and outer cylinders, lies wholly on one side of this central plane $L\,M$. In order to avoid any possible association of the intersections discussed with this circumstance, and to show that the modes of determining them are general and wholly independent of the relative positions of the cone and the screw surface, we have in Fig. 114 introduced a larger portion of the latter, and so located the element $y\,z$ of the cone that it intersects a number of the elements of the helicoid on each side of $L\,M$; and it will be seen that the pairs of similar triangles, from which the proportions involved in the demonstrations are derived, are formed in the case of the element $a\,c$ below $L\,M$, in precisely the same manner as in that of $b\,d$ above it, and the same is true of all the intermediate elements. Consequently the curve of intersection, as seen in the end view, will be a continuous spiral, right or left handed, according to the direction in which the apex of the cone points, and will undergo no change in either the direction or the law of its curvature by reason of its passage through the central plane.

Next, in regard to drawing a normal to this surface at any point. This, it will be seen, may be done without difficulty in the same manner as in the case of the oblique helicoid, explained in connection with Fig. 104, Lesson XV. For when the position of the point is known, we can draw through it an element, a helix, and a tangent to the latter, which with the element determines the tangent plane at that point to which the normal is perpendicular.

It will readily appear that, like the true helicoids, this surface may be "struck up" without the use of a pattern. The principle of the mode of operation may be, perhaps, more clearly seen by the aid of Fig. 115, which, it must be understood, is an illustrative sketch only, and not intended to resemble in detail the apparatus actually used in practical operations. In this figure, D is a straight edge, secured to a forked arm B, which embraces and is pivoted to the socket A; this is free to turn and also to slide on the vertical rod $C\,C$. The axis of the pivot is perpendicular to that of the rod, thus enabling D, whose lower edge prolonged would pass through the intersection of the axis, to swing in a vertical plane. E and F are portions of two thin cylinders, whose upper edges are cut to the forms of true helices of different pitches, the pitch of the outer helix being the greater. Now, the space between these two cylinders being filled with loam, it will be seen that the straight-edge D will scrape away the superfluous material, and the result will be the formation of the surface under consideration. The element $G\,H$ is horizontal, and therefore lies in the central plane, $L\,M$, of the preceding figures; and in moving thence to the position in which D is shown the operating edge resting upon the two helices, the outer end gains upon the inner one, as explained in connection with Fig. 107.

In Fig. 116, we give a drawing of a blade of a practical propeller of this description. The hub is of an ellipsoidal form, 14 inches long, 13 inches in diameter at the middle, and 11 inches at the end. The central plane of the hub also corresponds to $L\,M$ of our previous figures, it being stipulated that the element of the surface marked C C shall be perpendicular to the axis; so that while the aft part of the acting face is concave, the forward part is convex, as we have already seen. But it will be observed that the area of the part forward of this central element is considerably less than that of the part which lies aft of it, so that on the whole the concavity preponderates over the convexity, though, from the proximity to the central plane, neither the concavity or the convexity is very decided within the limits assigned.

The pitch, at the extreme diameter of the hub, that is, on a cylinder of 13 inches diameter, is 9½ feet, and at the rim of the screw, it is 10½ feet.

The blade of this screw is limited by assuming the space within which it shall turn; the meridian section of this space is shown in the side view in dotted outline, and it is quite different from the conical configuration previously used in several cases.

We may, and indeed must, employ the general method illustrated in Fig. 111, in determining from this outline the form of the blade in the different views. That is, we subdivide the pitch on the outline of the outer cylinder, and also either on the axis or on a line parallel to it drawn through the extremity of the central radius of the hub, into a convenient number of equal parts, and thus determine as many elements, revolved into the plane of the paper, as we may require for the purpose. In doing this, we again call attention to the circumstance that the division of the circumference and the pitch into twelfths, as the first step, is most convenient; for the pitches being respectively 10½ and 9½ feet, on the rim and on the circumscribing cylinder of the hub, their twelfth parts will be 10½ and 9½ inches, which, with the subdivisions of the former, can be at once marked off by means of the scale, which is more convenient than to use the advance on the axis, one twelfth of which we find to be $9\frac{3}{11}$ inches. Of course, the precise fractions of the pitch and circumference which will afford the greatest facility in execution will depend upon the conditions of each individual case; we wish to impress it upon the reader that usually some simple expedient, like that here mentioned, will enable him to work with greater rapidity than if he dashes off in a hap-hazard way; and to induce him to study his problem a little before he begins by which he will most frequently save time in the end. Now, the mode of subdivision having been decided on, each element in the side view is cut by the dotted outline of the assumed space in a point which is there seen at its true distance from the axis, which distance is then to be set off from the center on the corresponding radius in the end view, giving a point in the outline of the blade; and this point is to be counter-projected to a vertical line drawn through the original point in the side view, as was done in Fig. 111, in order to fix the location of the point in the actual side view of the blade; and from these two views the third is constructed. All of which the reader should be able to trace and indeed to execute, without any further detailed explanation of the diagram.

But there is one thing which needs a few words: It will be clear that in the end view the outline of the blade will be limited on the aft side by a radius tangent at some point p; which radius will clearly represent an element whose revolved position in the side view will be tangent to the assumed outline of the space swept out by the blade in turning.

Now, if this outline be arbitrarily fixed beforehand, it will be impossible to determine exactly either which element will be tangent to it, or the point of tangency, because the inclination of the elements is continually varying. In the true helicoid, when the angle with the axis is constant, we can draw without difficulty the one which is tangent to the curve; but in this case we could only approximate, by drawing elements very close together. For all practical purposes, the result thus attained would be accurate enough; but in planning the propeller, it will be seen that as a minute variation in this outline cannot possibly affect the working to any appreciable extent, we may draw the curve tangent to a known element at a known point. And this we have done in the diagram; assuming in the side view the point t at which the element is to be tangent to the dotted outline, $t\,x$ is drawn perpendicular to the element through t. This element is cut by the vertical line $v\,w$, 7½ inches aft of the end of the hub, which is the amount of overhang called for. If then we bisect the angle between the element and the vertical, the bisecting line will cut $t\,x$ in x, and $x\,s$ perpendicular to $v\,w$ will determine s, the point at which a circle whose center is x will be tangent to $v\,w$; and $x\,s$ being by the above construction equal to $x\,t$, this circular arc will also be tangent at t to the element as required.

It will be observed that s is the revolved position of this extreme aft point, the true position being marked r in all the views, the true position of t being marked p. These two points come so close together that in the end view it would not be easy to say from mere inspection which was the real point of tangency to the radius, or in the other views to the line $v\,w$. Owing to the peculiar reflex curvature of the dotted outline in the side view, there must be another radius tangent to the outline of the trailing edge in the end view.

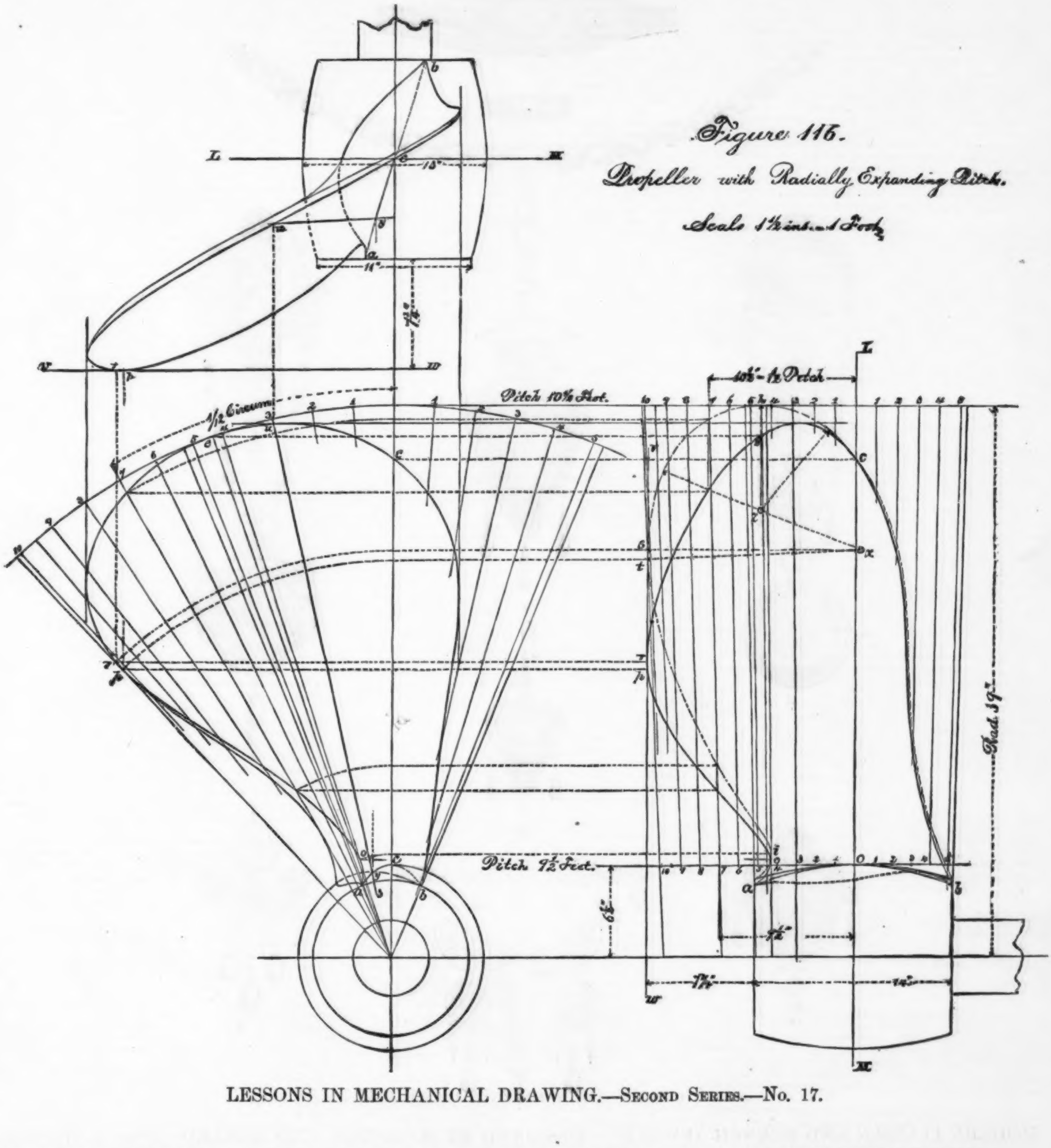
The point of tangency o is definitely located in a similar manner, by making the assumed dotted outline in the side view tangent at i to a known element. And the point e at which the outline of the blade in the end view is tangent to the circle of the rim, is also fixed by making the outline, of the space to be swept out, tangent in the side view to that of the outer cylinder at the extremity h of a known element. The upper part of this outline is an arc of a circle whose center z was found by trial and error, it appearing that by assuming the radius $z\ h$, this arc tangent to the continuation of $t\ s$ about center x, would coincide with the given irregular outline, the most of which is drawn by the aid of the sweeps before described, so closely as to be practically identical with it. On the forward side, it is clear from the form of the curve and the inclinations of the elements that there will be no tangency, and we must rely for all determinations wholly on points of intersection. This dotted outline contains the highest revolved positions of all points on the boundary of the blade; of which points the outer one marked c is also in its true position; so that the actual outline (drawn full) will there be tangent to the dotted outline of the space swept out.

We have, in order to make the drawing complete, added the thickness to the blade, and shown what is visible of the back But we have left the student to make the construction for himself, and shall here simply recapitulate the steps to be taken in doing it. We must, then, first make the "conventional section," by drawing a line on one side of the central element $u\ y$ in the end view, at a distance from it determined by drawing horizontals at short intervals, whose lengths are the desired normal thicknesses at those distances from the axis. We have next to draw a series of normals in their true positions, of lengths determined by aid of the conventional section, and pass a curve through their extremities. We must then find where this curve pierces the hub. The mode of doing this is shown in Fig. 111. Let $A\ B$, $A'\ B'$, be the two projections of the curve, and let it be required to find the point of penetration on the hub there shown. We may consider $A'\ B'$ by itself, as the base of a cylinder whose elements are perpendicular to the paper in the end view; then that cylinder will cut the hub, and we can easily find the line of intersection in the side view, by the now familiar mode of cutting both surfaces by a series of transverse planes. Thus, k' is to be projected to k on the central plane $o\ c'$; g' to the end plane of the hub, at g: the circle through m' is a section of the hub by the plane $p\ s$, and cuts $A'\ B'$ at n', which is projected to n. In this way we determine the intersection $g\ n\ i\ k$, which in its turn cuts $A\ B$ at V, which is projected to V'. Thus the point V, V' lies in the given curve, and also in the curve of intersection just found; but the latter lies on the surface of the hub, therefore the point thus found is the required point of penetration.

Next, we are to assume the curve at the junction of the hub and blade: which must pass through this point; then cutting the propeller by a series of concentric cylinders, we find the points in which the curve through the end of the normals pierces them, and through those points draw assumed curves of intersection between the cylinders and the back of the blade. The correctness of these sections is tested by making sections of transverse planes, which should be bounded by fair and regular curves; if they are not, the assumed curves are altered until the irregularities of the surface, thus indicated, disappear.

Thus it will be seen that the process to be pursued here differs from that illustrated in Fig. 90, in the case of the "true screw," or right helicoid, only in the detail of the operation of drawing the normal to the acting surface; which is as before stated, precisely the same as in the case of the oblique helicoid. And even this difference is due to the peculiar form of the blade in the side view; were the vertical element $c\ c$ there, that is, the one perpendicular to the axis, anywhere near the central element of the acting face, we should have used it instead of $u\ y$ in drawing the conventional section as well as the normals, and then the two operations would have been substantially the same throughout.

But there is enough of variety to make this construction a most advantageous exercise, which the student who wishes to be thorough in his mastery of this matter will not omit.



LESSONS IN MECHANICAL DRAWING.—SECOND SERIES.—No. 17.

REPRODUCTION OF FRESCOES.

By COUNT LUDOVICO DE COURTEN.

AMATEURS who are not fortunate enough to possess a glazed studio, and often have not even an uncovered terrace at their disposal, are compelled to make their reproductions of engravings, drawings, etc., or of any other flat design, in the vicinity of a window. The difficulty of operating is very great when one attempts to work in museums or picture galleries, and any hint, therefore, which will facilitate one's labors is not to be despised. One of the principal defects when the object is opposite a lateral opening consists in the inequality of the lighting, the side nearest the daylight being much more brilliantly illuminated than the opposite side; and as it is necessary, in order to get at the proper distance,

to place one's self on one side, at a very wide angle, it follows that a lengthened pose is necessary. Direct sunlight permits of the reduction of these defects to a minimum. Unfortunately, one cannot always place the camera to the best advantage on the proper side, and the sun, as it rises, soon deprives one of the advantages one hoped to gain.

There is, however, a method of getting out of the difficulty, which consists in the employment of ordinary mirrors of quicksilvered glass. They reflect most of the incident light which is necessary to the purpose. A surface measuring forty by forty-five centimetres will answer wonderfully well. This mirror is held in the hand, and during the exposure the rays of light are directed upon the object to be reproduced, care being taken to oscillate the surface a little, so as thoroughly to equalize the illumination. The exposure is very rapid under these circumstances.

By employing two mirrors instead of one the rapidity is doubled, and any inequalities in illumination are destroyed in the most effectual manner. Even in the case of a pose in direct sunlight, the shadows may be advantageously combated, which are formed by a rugged or uneven surface. The great simplicity of the method, and its incontestable utility, are enough to recommend it.

It is by employing large mirrors in this way, reflecting upon any given surface, that details and minutiæ badly lighted up are reproduced on the frescoes at Florence. Therefore, in the reproduction of engravings, the same plan would be advantageous.—*Moniteur de la Photographie.*

DESIGNS FOR JEWELRY.

THE set, Fig. 1–4, by Rafaello Bonacina, in Milan, executed in gold, enamel, and pearls, the oval center being blue, the other ground deep-red enamel.

Figs. 5, 6, 7 show Parisian manufacture, the chatelaine, Fig. 5, style Louis XIV., in chased gold; Fig. 6, style renaissance in enamel, pearls, and brilliants; brooch, Fig. 7, style of 18th century, in chased gold. Figs. 8 and 9, necklace and ear pendants, by Paul Benard, architect, in Paris, in pearls and brilliants, with gold mounting.

MODERN ITALIAN AND FRENCH JEWELRY. DESIGNED BY BONACINA AND BENARD. *From the Workshop.*

DIAMONDS AND OTHER PRECIOUS STONES.

THE South African diamonds are found over many hundred square miles of territory. The principal diggings are situated in the valley of the Vaal River, to the northeast of the Orange River Free State, and within the boundary of the Cape Colony, as now defined. The country here rises into long stony ridges, consisting of irregular fragments of hard rock imbedded in ferruginous gravel, which varies in character and compactness, being sometimes quite loose, and sometimes forming a compact lime-cemented mass. It is in this gravel that the diamonds are found. They occur at various depths down to twenty feet or more, but the usual depth is from two to six feet below the surface. The manner of work is simple enough. A claim or piece of ground, thirty feet square, is occupied by two diggers in partnership, assisted by their black servants. They remove the loose blocks of stone, which are cast aside. They take up the gravel and sift it thoroughly, either in a dry state or with abundance of water in a sieve rocked by a cradle. When the pebbles have thus been separated from the sand they are cleansed and placed upon the sorting table, to be carefully examined for any diamonds that may lie among them. The Brazil mines were believed to be the richest in the world. Diamonds weighing from twenty to thirty carats were not unusual, and among the exceptional treasures found were diamonds weighing considerably more than 100 carats, including the beautiful "Star of Beaufort" and the "Star of Diamonds," weighing 107½ carats; and a lovely stone, which attracted especial attention by exhibiting under the microscope an aspect of pointed mountain summits, lighted by vivid sunlight with all the colors of the rainbow. One of the most celebrated diamonds is that of the Rajah of Matteen, in Borneo. It was found on that island, and weighs 318 carats. It is shaped like a pear, and is considered by the people of Borneo as a kind of palladium, to which the destinies of the empire are attached. They attribute to it the miraculous power of curing all diseases by means of the water in which it has been dipped. According to Jamieson, the Governor of Borneo offered for it £30,000, two large war brigs, with their guns, ammunition, and stores, and seventy cannon, with a large quantity of powder and shot; but the Rajah refused to part with it. The story of the celebrated regency diamond is told by St. Simon, who professes to speak of his own personal knowledge. He says that the diamond was stolen by a person employed in the diamond mines, who escaped to Europe with it, and after showing it to several

princes—and among the rest to the King of England—passed over to Paris, and showed it to the somewhat notorious Law.

Law proposed to the regent that it should be bought for the King, but the state of the finances was such that the Duke hesitated to spend such a large sum in that way. St. Simon lent his influence in favor of the purchase, representing that the diamond was peerless in Europe, and would well become the crown of France, and that the purchase of it would shed glory on the regency of the Duke. The latter at last consented, and the diamond was bought for £75,000, others say £129,000, the seller receiving also the fragments resulting from the cutting, with interest on the price till the whole was paid. From that time the regent became identified with the fortunes of France, and a chapter of historic details belongs to its career. It has passed through many revolutions, and has literally gone through many hands, for in the days that followed the fall of Louis XVI., the regent, carefully chained and guarded by gendarmes, was exposed to the people of Paris, and any half-starved workman who chose might hold this symbol of royal splendor and epitome of twelve million francs for a few moments in his brown hands. The regent, pawned to the Batavian Government by Napoleon I., stolen by robbers, and its hiding-place revealed at the gate of death by one of the reckless band, and, mounted in the state sword of the First Napoleon, finally glittered in the imperial diadem through the palmy days of Napoleon III. The adventures of the Koh-i-noor, how it passed from one hand to another, and was made the pretext for fraud, for intimidation, for murder, and even for war, are all so well known that their recapitulation is useless here. When the Koh-i-noor was brought to England it weighed 186 1-16 carats, and was valued at about £140,000. At that time it was merely surface cut, and was also disfigured with several flaws, so that re-cutting seemed advisable; and it was decided to give it the form of the brilliant. The cutting was begun on July 16, 1852, and the Duke of Wellington being the first person to place it on the cutting mill, it was finished September 7, thus occupying in all 38 days of 12 hours each. In cutting its weight was reduced 122¼ carats, but the stone is nevertheless valued at the same price it was before, on account of the improvement in brilliancy and effect. Besides the Koh-i-noor and a great number of fine pearls, the crown of Queen Victoria contains 497 diamonds, of which the value is estimated at more than £74,000. The country most rich in diamonds at present is Russia. Besides special collections of diamonds in the treasury of this empire, there are three crowns of which they form the sole jewels. The first, that of Ivan, contains 881; that of Peter the Great, 847; and that of Catherine the Great, 2,536. Among the large diamonds in Russia the most remarkable is the Orlow. It weighs 193 carats, and is one of the ornaments of the imperial sceptre. This beautiful diamond was originally from India. It formed formed for a century and a half one of the eyes of the famous idol of Serringham, in the temple of Brahma; the other eye was a diamond of the same order. At the commencement of the eighteenth century the idea seized a French soldier of one of the French garrisons in India to steal the eyes of this celebrated idol. He pretended to be inspired with a wonderful zeal for the Hindoo religion, and gained to that degree the confidence of the priests that they confided to him the care of the temple. He chose his time, and one stormy night carried off one of the diamonds; the other could not be freed from the socket. He fled to Madras, where he sold the stolen treasure to a captain of the English navy for £1,860. Conveyed to England, it was bought for £11,160 by a Jewish merchant, who some time after sold it to Catherine II. for £83,700 and a pension for life of £3,720. A precious stone without a rival is the blue diamond of Mr. Hope. Its weight is 44¼ carats, and its color is the blue of the most beautiful sapphire, added to an adamantine lustre of the utmost brilliancy. It was purchased for £16,740, but competent judges declare that it is worth more.

The classification of jewels by Babinet arranges all precious stones in three classes. The first comprises a single stone—the diamond—which is composed only of carbon. The second comprises all jewels the base of whose composition is alumina. The list of these is much more varied than might be supposed; since it contains stones as varied in appearance and color as the sapphire, the ruby, the Balas ruby, the Spinel ruby, the topaz, the emerald, the beryl, the aquamarine, the cymophane, and the turquoise. Alumina is the base of the common red and yellow clay which is found everywhere in the utmost abundance, and the only mark of distinction known to chemists between the common clay and the sapphire, or the emerald, is the fact that the latter are crystallized, and contain traces of metallic oxides which give color to the stones. The name corundum is applied by mineralogists to all varieties of crystallized alumina, whatever their color. Colorless corundum is so brilliant as sometimes to be mistaken for a diamond, but it may be readily distinguished by its double refraction, and by its small specific gravity. The corundums are often exceedingly valuable, rubies of perfect lustre and purity being of greater value than diamonds. The ruby ranks first for price and beauty among all colored stones. It is of the pure red of the spectrum, and next after the sapphire is the hardest of precious stones, always excepting the diamond. Charles Achard, the highest authority in France in all that concerns the traffic in colored stones, remarks that weight has not the same effect in their case as in that of the diamond. Every diamond, from the very smallest specimen upward, has its value, like gold and silver, according to weight; but in the case of rubies and other gems the little specimens have hardly any value, and these stones only begin to be appreciated at the moment when their weight withdraws them from the common lot, and assures at once their rarity and high price. When a perfect ruby of five carats enters the market, a price will be offered for it double the price of a perfect diamond of the same weight; and if a ruby reaches the weight of ten carats, it will bring triple the price of a diamond of the same weight (from three to four thousand dollars). The carbuncle of the ancients is the same as our modern ruby. The most fantastic qualities were formerly ascribed to these wonderful stones. The carbuncle served to furnish light to certain great serpents or dragons when old age had enfeebled their eyes; they constantly carried these magical stones between their teeth, only dropping them when it was necessary to eat and drink. According to St. Epiphanius, the carbuncle has not only the property of shining brilliantly in darkness, but its light is of a nature so extraordinary that nothing can arrest it, so that it shines, for instance, through vestments with undiminished fire.

Stones composed in whole or in part of silica are much more numerous and much less valuable than the aluminous stones. Quartz, transparent and colorless, is the purest specimen of silica that can be obtained; and though, when colored by the mixture of other ingredients, it receives a variety of names, it is no more changed in nature than would be the pieces of the same silk which had received each a different color from dyeing.

Crystals do not ordinarily attain large dimensions. Compared with the greater number of minerals, crystals of two inches are almost gigantic; few, indeed, exceed four inches in height. Quartz, however, forms an exception to this rule. Specimens are brought from Madagascar more than twelve inches in length, and remarkably pure and transparent, notwithstanding their great size. The rock crystal of that island is used for the object glasses of astronomical telescopes. Magnificent crystals have also been found in the Alps. One of these Alpine crystals, taken in Italy by the French, was borne in triumph in Paris in 1797. There is a beautiful specimen in the Museum of Natural History at Paris, which measures three feet every way, and weighs nearly 800 pounds. At the French Exhibition of 1867, in the section of Japan and Brazil, there were some wonderful crystals. One brought from Brazil weighs 212 pounds, is 2¼ feet high, 1 foot in diameter, and is a perfect six-sided prism. A remarkable phenomenon in quartz is exhibited by the fluid drops contained in many specimens. Sir David Brewster ascertained that the fluid is not water, but of an oleaginous nature, one part volatile at 27 degrees, and the other a fixed oil. Dana has named the former cryptoline, and the latter brewsterine. Some beautiful specimens of quartz crystals, beaded with those imprisoned drops, have been found at Trenton Falls,

Quartz has but little value of its own, but when it is made into vases, cups, and other artistic objects, it acquires a high price. The Athenians produced some exquisite works in rock crystal, and the Romans valued it very highly in the form of vases. Nero had two cups of it, which he broke in his rage when he heard of the revolt that caused his downfall. One of these cups was estimated at over £:80. The elegants of Rome were in the habit of using rock crystal to cool their hands, and certain occult charms were also said to reside in these smooth, cold globes. In the middle ages the Venetians produced some beautiful objects in rock crystal; and Milan has long been famous for its statuettes, vases, and girandoles of this material. But desire of gain has deteriorated the artistic value of these productions. Cut crystals have come to be sold by weight, and the cutting is naturally falling into neglect. In the cathedral at Milan the burial shrine of Charles Borromeo is wholly formed of plates of rock crystal of six or eight inches square each, set in a framework of silver. The shrine was the gift of Philip IV. of Spain, who employed eight years in collecting the necessary quantity of rock crystal. When crystals of quartz are found combined with certain traces of coloring matter they constitute distinct species in commerce, and take completely different names. Combined with iron and alumina, quartz becomes yellow, and takes the name of the Bohemian topaz. Impregnated with a bituminous substance, it becomes more or less darkened, and is called the smoky topaz. Combined with a slight proportion of oxide of manganese, it takes a beautiful violet color; it is then the occidental amethyst. Colored blue by iron and alumina, it becomes the water sapphire. Colored rose by iron and manganese, it is the Brazilian ruby. Combined with a notable proportion of oxide of iron, it becomes a brown red, and constitutes the hyacinth of compostella. But among all these varieties, there are only two that are really valuable, the amethyst and the water sapphire. The amethyst of commerce is mostly furnished by Brazil. In that part of the world amethysts attain to an enormous size. A block of amethyst, sent from Brazil to Calcutta, is said to have weighed 98 pounds. Some of the Brazilian specimens are of two colors. Count De Bournon possessed a cut and polished stone of this kind, half violet and half yellow. The ancients believed that wine, when drunk from an amethyst cup, lost the power of causing intoxication. Accordingly the attributes of Bacchus are found engraved upon ancient cups of amethyst. Under the name of false jewels are comprised three kinds of articles, the first being stones sufficiently hard to resist a file, the second being artificial productions of the nature of glass, and the third being what are called doublets, It is of some importance to examine this subject, because there is a prevalent belief that all false stones necessarily have glass as their base, and are consequently of little hardness. People often say when their rubies or their topazes are declared false—"But see, here is a file; try to scratch these stones; you will not succeed." Very true; but submit any piece of quartz to the same test, and the result will be the same. Since, as we have said, hyaline is very abundant in nature, it is easy to procure, at insignificant prices, stones that perfectly resist the file, and show, often in a remarkable manner, the whole series of colors that we admire in real precious stones. The colorless varieties of sapphire and topaz, which in density, in hardness, and in refractive power differ but little from the diamond, are frequently cut into roses and brilliants, and sold for diamonds. A proof of this fact is furnished by the commercial price of the colorless topaz, which is much greater than it could obtain as topaz. It is valued in the secret hope that after cutting it may be sold for diamonds. The doublet method of imitating precious stones, though varying in a great many respects, is generally effected by giving the proper shape to a morsel of strass (a peculiar kind of glass), removing from the upper portion of it a certain thickness, and replacing this by hard stone, in such a way as to complete exactly the strass stone; then mounting the whole in a setting that completely conceals the line of junction of the two stones. Doublets are of two kinds—in both the under part is strass: but in one the upper part is a plate of the real stone; in the other it is simply hard stone, generally quartz, and of no value. The description of the method of manufacture in the fifteenth century is given by Cardan, who has even preserved for us the name of the inventor. A fraud of a very bad character, and one very difficult to find out, was employed by Zocolino. This venerable personage used to take a thin flake of real precious stone, such as carbuncle or emerald, choosing such pieces as had but little color, and were consequently very cheap. Underneath he placed a piece of crystal, sufficiently thick, and united in two parts by means of a transparent glue, in which he incorporated a coloring matter in harmony with the stone he meant to represent, brilliant red for carbuncle and green for emerald. He concealed the line of junction of the two parts by means of the setting, and to avoid giving rise to suspicion he set them in gold, which was not allowed except in the case of real precious stones. In this way this magnificent workman deceived everybody, even the lapidaries. However, the fraud was at last discovered, and Zocolino took refuge in flight. It appears that this person had a peculiar disposition for fraud, for he turned his attention afterwards to the fabrication of counterfeit money, and ended by being condemned to death. An examination of the objects adorned with precious stones that were executed in the middle ages shows that the process described by Cardan was not unfrequently employed.

WOMEN AS PHYSICIANS.

IN her Introductory at the London School of Medicine for Women, this fall, Mrs. Garrett Anderson, M. D., referring to the general question as to the admission of women to the medical profession, said that no arguments would influence the opinion of those who disliked the innovation, and that, in her opinion, the real defence would be found in experience and not in argument. Whether women can be trained to be first-rate doctors or not, and whether it is a solid advantage to society to have them so trained, are questions which can only be answered by experience on a somewhat large scale. Many of the objections commonly urged are, no doubt, imaginary. It is quite certain that women can study every part of the medical curriculum as seriously and thoroughly as men can, and that they do, to say the least, quite as well in the examinations.

On the other hand, some of the arguments used in favor of the change seem open to question. It has been said, for instance, that women will understand women's ailments better than men will; but Mrs. Anderson would warn the students that they would understand disease according to their intelligence and knowledge, and not by virtue of any occult sympathy or intuition. Women, however, would understand, better than men could ever do, the conditions of life which underlie a vast amount of feminine ill-health. It needs a woman to sound the depths of dullness in the kind of life too frequently led by unoccupied women, and to understand how destructive it is to nervous health. No young man in England knows what it is to live an indoors and idle life, without work and play, and under perpetual tutelage.

With regard to the argument that medical women will marry, Mrs. Anderson remarked that society was concerned, not with the quantity of work which a medical woman could undertake, but with its quality, and that if medical women marry they must bear this in mind.

In conclusion, the lecturer urged the importance of carrying the community with them by judgment, moderation, and good taste. She begged the students also to remember that they were not now mere isolated units in society, not merely women who desired to help, according to their several lights, the best interests of all women, but that they were now members of a noble profession, and that they had the responsibility which is linked with comradeship toward every other medical person, whether man or woman. Let them free themselves from petty jealousies, ignore all that is opposed to comradeship in the attitude of others toward them, and seek in all things to promote the highest aims and interests of the profession, help to purge it of its flaws, and to add to its honor.

THE SCIENCE OF TEMPERANCE.

In a late lecture with this title, Dr. B. W. Richardson, of London, made the following points: *First:* That the substance now called alcohol, and which had been so called for some three centuries, could not be considered as a food, as most people supposed—standing alone in the world as something which was to be taken as if it were a food. *Second:* That common alcohol was, therefore, not a special gift sent to them to be used as food, any more than the other chemical bodies coming under the head "Alcohol." *Third:* That when, as physiologists and biologists, they looked on the construction of the animal kingdom, and considered how it was made up of certain fluids and solids, they were struck with the fact that there was no provision whatever made for the use of such an agent as alcohol. Nature had produced the organization simply of one fluid, and that fluid was water. *Fourth:* That ethylic alcohol acted on the bodies of men and animals in the same manner as other chemical substances. It did not act after the manner of a food at all, but produced effects which were phenomenal in their character. He found that a fatal dose meant a proportion of a drachm of fluid to the pound weight of the warm-blooded animals. In a man weighing 120 lbs., a dose of fifteen ounces would certainly be fatal unless scientific means averted death. The lecturer then graphically described the phenomenal effects of various doses of alcohol on the organism, and remarked, in conclusion, that if alcohol did anything that was of use in the animal organization, it was only in the first stage of this action.

DEATH TO MOSQUITOES.—Mrs. H. K. Ingram read a paper before the American Association for the Advancement of Science, in which she alluded to the fact that all the mosquitoes in a room can be destroyed by exploding a small quantity of gunpowder in the apartment. She thinks that similar explosions might be employed to destroy the phylloxera of the grape vine, and the "germs" of disease.

LECTURES ON PARALYSIS AND CONVULSIONS AS EFFECTS OF ORGANIC DISEASE OF THE BRAIN.

Delivered at the Bellevue Hospital Medical College, N. Y., 1877.

By C. E. BROWN-SEQUARD, M. D.

LECTURE IV.

GENTLEMEN In the last lecture I attempted to give you facts that prove that a lesion on one side of the brain can produce the greatest variety of paralyses. You may perhaps think, therefore, that it is an extremely difficult matter to diagnosticate and to localize the lesion in brain disease. No doubt it is a most difficult matter, but I shall give you numerous facts which will enable you to do this with a certain degree of positiveness.

I had almost forgotten to mention a theory of Dr. Broadbent, of London, advanced to explain the difficulty in determining the seat of a lesion, which is the cause of paralysis. In most cases of hemiplegia from brain disease the paralysis is limited to the arm, leg, and face. There are many parts of the body that escape paralysis, and these parts are generally the muscles of the trunk and neck, and the connecting muscles of the limbs—that is, those muscles which are attached on one side to the trunk, and on the other to the limbs. In the immense majority of cases of hemiplegia these muscles are exempt from the paralysis that affects the other muscles. Now Dr. Broadbent said that certain parts of our system depend for their power of motion on a center at the lower part of the pons Varolii, or the upper part of the medulla oblongata. He admits that one part of the corpus restiformis is alone sufficient to move two sides of the body, and, therefore, these muscles escape on both sides, when one side only is diseased. This theory is true in a measure, but otherwise it is false, because he considered this portion of the gray matter as a center for these muscles. The reality is that one part of the brain is sufficient for the whole body.

Now, from these facts I will pass on to the consideration

of the significance of certain symptoms by which we are enabled to locate the seat of a lesion that causes paralysis.

There is one fact that it is very important to understand fully. You very well know that there are a number of nerves arising from the base of the brain that serve for the various special senses, for tactile sensibility, and for motion also. Now we must make a distinction between cases of paralysis that depend on a disease which strikes at the place from which the nerve comes, that is, a lesion that strikes at the trunk or roots of origin of a nerve, and those cases in which the lesion is beyond the point of entrance of these nerves in the base of the brain. Take, for instance, a cell in the medulla oblongata which is connected with a motor nerve fibre. Now a disease anywhere between the cell and the periphery of the medulla, or over the position of the cell, destroys the fibre of the nerve, and also the cells from which it arises. It is the same as if the nerve were destroyed beyond its point of exit. But suppose the disease is situated beyond these cells, in a portion from which there are no nerve fibres arising. Here there is something completely different—the nerve fibres or roots are untouched. In those cases of paralysis which depend on the destruction both of cells which give rise to nerve fibres and the fibres, or that depend on the destruction of the fibres themselves, or that depend on the lesions that strike the cells themselves, there is something different from those cases in which the lesion strikes those cells that are beyond the cells from which the fibres arise. In all that I said in the last lecture of paralysis of the eye, tongue, face, etc., I had reference only to disease of cells which are in connection with those nerves that supply the parts spoken of. When you have a disease striking at a nerve or its root before its origin from the base of the brain, the paralysis occurs on the same side as the disease, and this fact is very evident, for it is the same thing as if you divided the nerve itself in any part of its course.

In what I shall now have to say as regards the diagnosis and localization of cerebral disease, what I have said in reference to the difference that occurs when the disease is situated at a point where the cells give origin to the nerve fibres, or where it is located at a point beyond it, is of the very greatest importance.

For the sake of illustration, let us take a disease situated in the pons Varolii. In two cases, in one of which the disease is situated above the origin of the facial nerve, and in the other where the lesion is located at the root of the nerve, there will be a characteristic difference. In the second case, where the disease is on the root, or the cells of origin of the root of the nerve, the face will be affected on the same side as the lesion. In the former instance, if the disease is located elsewhere, beyond the cells of origin, the face will be affected on the opposite side.

Now as regards the limbs. As a rule, we find paralysis on the opposite side of the body from that on which the disease occurs. When a disease strikes the origin of a nerve the paralysis is on the same side. We find this true likewise in the case of all the nerves of the brain, whether or not they be nerves of motion. The olfactory, optic, or any other of them are similarly affected.

But to come now to the diagnosis of various cases of hemiplegia. We will first point out the differences that exist before coming to the points concerning particular locations. Disease of the upper part of the spinal cord, as well as of the brain itself, can produce hemiplegia. Take two individuals who are suddenly struck down with loss of consciousness and some trace of convulsions. After recovery from the first symptoms you find that there is paralysis in one-half of the body. Suppose it to be the right half of the body in both cases. One of these individuals makes a grimace on the opposite side of the face, and you might consider that the disease is on the same side. (This point has not been mentioned in any of the text-books, and has been noticed only by myself.) If you pay attention only to the paralysis on the left side of the face and the right side of the body, you will be led to believe that the lesion is situated in the brain. You might, however, be seriously mistaken, because a lesion of one-half of the spinal cord, near the medulla oblongata, can produce all of these symptoms.

In many cases the side that seems to be paralyzed is not really the paralyzed side. In fact, there may be no paralysis at all. The appearance of paralysis may come from the fact that a spasmodic state of the muscles exists. In certain cases of spinal hemiplegia the disease is limited to one-half of the cord. In these cases you will find features that make this form of paralysis distinguishable from those cases of paralysis that are due to disease of the brain, putting aside only two or three cases that I know of. If you examine the patient carefully you will find, if the lesion be on the right side, paralysis of the two right limbs. There is no diminution of sensibility, but, on the contrary, a very considerable increase of sensibility, as measured by the æsthesiometer—the compasses of Weber, modified. Instead of only being able to detect the two points of the instrument at a distance of three lines from each other on the palm of the hand, which is the normal distance in that location, the patient may be able to appreciate the two distinet points when they are nearer to each other. This hyperæsthesia may be very great.

In the case of Charles Sumner, who was struck down on the floor of the Senate Chamber, the back part of the spine was injured. On the back part of the neck he could recognize the two distinct points when they were almost touching. In the spinal region, in the normal condition, the points of the instrument must be two inches apart in order to be recognized distinctly. There is, then, considerable hyperæsthesia: in other words, the normal sensibility is very much increased in spinal hemiplegia.

Besides the abnormal increase of the tactile sensibility, the sensation of pain is also much greater. In some cases a slight touch may be so painful as to cause the patient actually to scream. There is likewise an increase in the power of detecting temperature, the patient, often, not being able to bear the contact of anything hot or cold, the pain produced is so great. There is likewise increase of the power to recognize the sensation of tickling.

Another feature is that the muscular sense is not impaired. Indeed, when the patient recovers a little, he will know where the limb is, without first having to put his hand on it to feel.

On the side opposite to the disease there may be a great loss of sensibility.

As regards the temperature of the parts, there is another important feature. The surface is very much warmer on that side on which the muscles are paralyzed. There is an increased temperature on the side of the paralysis and a diminished thermometric height on the opposite side. You will likewise find the face warmer on the side of the lesion. You get the same results as if the fibres of the sympathetic nerve are divided on that side of the cord. There will be great redness of the face, of the eye, and of the ear.

The pupil of the eye is also dilated on the same side. This effect follows galvanism of the sympathetic nerve of the head. The muscles are contracted simply because of the increased afflux of blood to the parts. The effects do not depend upon a changed condition of nervous centers, but upon a greater tonicity of the muscles, which results from their increased supply of blood. In localizing the lesion in these cases, besides this positive evidence, we have the fact that a great many other symptoms that are present when there is disease of the base of the brain do not exist.

In a case of disease of one-half of the spinal cord there is usually a feeling of stricture on one-half of the body at the level of the lesion in the cord. A lesion in the spinal cord, although it may destroy a great deal of tissue in its vicinity, only alters some of the sensitive roots in its neighborhood in such a way that hyperæsthesia is produced. The body is thus separated into three zones—two of hyperæsthesia and one of anæsthesia. There is nothing at all of this kind in disease of the base of the brain; so you see that the diagnosis can be made very easily in this way.

When the disease is situated in the medulla oblongata or pons Varolii, the general symptoms are extremely interesting. It is very necessary to be able to diagnosticate clearly the exact seat of the lesion in such a case, for the prognosis depends altogether upon the diagnosis, and the means of treatment to be employed in all cases are not the same, but must vary according to the seat in the base of the brain. The chief point is this, that the nerves implicated show the locality in which the disease is situated. Suppose that the crus cerebri, pons Varolii, and medulla oblongata are destroyed; in other words, almost the whole of the base of the brain, behind the optic bands. You then find that all the nerves that take origin here are more or less implicated. If you know what these nerves are, you can readily understand the results that are produced. When the third pair are involved you find the effect in a change in the motor power of the eye. The ball cannot be moved upward, downward, or inward. The effects are very complex, but they are in harmony with what we know of the function of these nerves.

The paralysis, instead of being on the same side, is on the opposite side in the limbs, and the loss of sensation appears where the loss of motion exists. In disease of the spinal cord you will recollect that I said there was no anæsthesia on the affected side, but, on the other hand, a hyperæsthetic condition. Here there is a loss of feeling on the same side as the loss of motion.

The urinary secretion is disturbed. It is increased immensely in amount, with or without the presence of sugar. You know there are two kinds of diabetes. Diabetes insipidus, which consists in the excretion of a very large quantity of urine, which, however, does not contain sugar, and a second variety, termed mellitic diabetes, in which the urine contains sugar. These two forms are very common in cases of disease of the whole base of the brain, and may exist in disease of any part of the brain, but it is never present in disease of the spinal cord.

I showed in a previous lecture how a lesion of the pons Varolii or medulla affects the lungs, almost in every instance and at once, in animals, and likewise very frequently in man. One of the first effects of such a lesion is to produce a considerable congestion of the lungs. In disease of the pons Varolii, in that portion just where the crus cerebri enters it, we often have a hæmorrhage of the lungs, sometimes slight in amount, but often sufficient to cause death. This pulmonary hæmorrhage may occur in connection with a hæmorrhage at the base of the brain, and some have supposed both lesions to be due to the same cause.

Charcot and Bouchard discovered that cerebral hæmorrhage almost always occurs as the result of the rupture of an aneurism. Very frequently in persons past fifty years of age the walls of the arteries enlarge, and as there is no thickening, but, on the contrary, a thinning, the walls break, and the hæmorrhage is almost invariably due to this cause. As it has been found that sometimes the veins of the lungs are in the same condition, it was thought that a hæmorrhage in those organs depended on the same causes, and was coincident. It is so perhaps sometimes, but when a hæmorrhage in the lungs follows quickly after a lesion in the brain, the latter is the cause of the former, perhaps by changing the circulation.

I have found that the pulmonary hæmorrhage depends on the following cause. Suppose the capillaries of the lungs are congested, contraction takes place in both the veins and arteries. The capillaries are then very much distended by the stagnant blood, they break, and you get the hæmorrhage. This is one of the frequent causes of death in disease of the pons Varolii, and it is a cause that has been altogether too insufficiently noticed, and, unfortunately, when people die from disease of the brain, the lungs are not properly examined. This is reprehensible, because many changes may take place in the lungs in consequence of brain disease, and they probably do in about one case out of every ten. First, there may be an active congestion, and then an inflammation. Foci of inflammation are frequently found in cases of disease of the brain. As the patient has always most difficulty and danger from his brain disease, the lesion in the lungs is overlooked, and proper local treatment is not applied. I have not the slightest doubt that a great many cases of death are due not to disease of the brain, but to subsequent disease in the lungs, which has passed entirely unnoticed.

Now another effect of very great interest can take place in disease of this portion of the base. The par vagum originates in the medulla oblongata. When the nerve is galvanized a stoppage in the heart's action is produced. The bearing of this fact is obvious. A lesion in this situation produces irritation of the par vagum and consequent diminution of the beating of the heart. This may be slight, or sufficient in itself to produce death. In many cases of disease of the bones in this neighborhood we have pressure on the par vagum which is sufficient to cause stoppage of the heart. The beating is diminished in force, but not in frequency, until finally the force of the contractions is lost entirely.

The œsophagus, pharynx, and larynx all receive their nervous filaments from the pneumogastric nerve, and when there is irritation in its origin there may be spasm of all these parts. In a case that I shall always remember, of a very dear friend of mine, there was intense spasm of the œsophagus. During the eight days that he survived from the commencement of his illness it was impossible to get anything whatever into his stomach—impossible even to introduce a tube, the spasm was so great. We injected pancreas and beef into the rectum, and in this way managed to nourish him during the time he lived. I may say, in passing, that this is the very best method of feeding a patient when we cannot get the food into the stomach. In the case I have mentioned life was prolonged for eight days without the slightest diminution in the weight of the body—without any wasting away or emaciation.

A disease pressing on the origin of the trigeminal nerves may be very easily diagnosticated by the changes produced in the state of the cornea. This membrane becomes inflamed, and, after a time, ulcerated. Magendie showed long ago that when the fifth pair was divided an alteration of nutrition was produced and the cornea entirely destroyed in a short time. He demonstrated also that all the senses were impaired, and he concluded that this nerve was concerned in all the special senses. He never would have drawn this conclusion if he had known the difference between loss of function produced by irritation and loss of function caused in a direct way. The nutrition of the organs of special sense is altered by an injury to the trigeminal nerve, and this fact is borne out by an abundance of other facts. A blow on the frontal nerve, or on another branch of the fifth nerve, may produce a total loss of sight. We do not conclude that it is therefore the nerve of sight. This result must take place through a reflex action, an irritation starting back from the seat of injury, and propagated again to the blood-vessels, thus materially altering the nutrition.

A disease in the optic thalamus, a part of the brain far removed from the origin of the trigeminus, can produce the same effect as division of the nerve itself. There is, therefore, nothing essentially belonging in a direct way to the trigeminal nerve, as regards vision, when it is diseased.

When there is a loss of feeling in the face on one side, and a loss of the senses, and of the cornea on the same side the lesion that produces them is on the same side of the brain.

Some ten years ago a patient consulted me in Boston who had paralysis of the limbs on one side of the body, with paralysis on the same side of the face, and I concluded that the lesion was situated in the pons Varolii on the same side. A short time afterwards he died, and at the autopsy the lesion was found in the spot indicated. The diagnosis was made from a consideration of the symptoms that appeared in the face. A disease in the pons Varolii may produce paralysis on the same or on the opposite side of the body, together with symptoms in the face on the same side as the lesion. Thus you see we are enabled to localize the lesion, and it does not always cause alternate paralysis.

You may also have a lesion in that part of the brain at the origin of the trigeminus without paralysis of the limbs. In such a case you might think that the trigeminal nerve alone was affected, that the lesion was limited entirely to it, but this is not necessarily the case, as a great part of the pons Varolii may be destroyed without any paralysis, except of the nerves arising there. In a case reported by Prof. Stanley, of St. Bartholomew's Hospital, London, there was a very extensive lesion of the pons Varolii and paralysis on the same side of the face only, and the eye was destroyed.

Another feature that we find present in cases of disease of the brain is, that instead of anæsthesia, you may have hyperæsthesia in the paralyzed limbs.

Sometimes you will find a remarkable absence of symptoms. Convulsions may be produced by irritation of the pons in animals, but it is not so in man. You get convulsions with least frequency in disease of this part of the brain.

Near the pons Varolii there is a portion of the brain that connects it with the cerebellum, called the crus cerebelli. Disease in this part may produce a rotatory movement round the main axis of the body, or cause progression in a circle. However, such a movement is not specially limited to disease of this part, as a lesion in other parts may cause it as well.

If we now ascend and place our attention on the crus cerebri, the diagnosis of a case of hemiplegia depends on the facts that follow. The paralysis, as I have so frequently observed, may appear on the same or on the opposite side of the body, usually, however, on the opposite side. There are two well-authenticated cases reported, that I know of, where it appeared on the same side. The crus cerebri has been considered as the only bond of union between the will power and the conductors in the production of voluntary motion and the perception of sensation. You should have, consequently, in disease of this part, anæsthesia and paralysis on the opposite side of the body. But this is absolutely false. Thirteen cases of disease limited to this part of the brain have been pretty well studied, in which no such facts were seen. Cases of complete paralysis are few, and of complete anæsthesia are very rare indeed. So little is the old view true in these cases that there are ten in number of them in which there was no paralysis at all, though the whole mass of the crus was destroyed. These are extremely clear cases that show that one crus is sufficient for the transmission of voluntary motion and sensibility.

I have said that in these cases paralysis seemed not to exist at all. It is possible that in the future there may be other means employed to discover paralysis. If a man can walk and stand, and can grasp firmly, you are inclined to think that there is no paralysis. I have frequently said, in the course of my remarks, that in many cases of disease in certain portions of the brain there is no paralysis. I must say, however, that it is my belief that, if we studied these cases more carefully, we should find paralysis more or less marked.

I here show you an instrument, invented by a friend of mine, which enables us to detect paralysis more accurately in parts that we could not determine the power of, so well before its introduction. It consists of two bars fastened on each end to a leg, and the legs coming from each side cross each other in the same manner as the legs of a saw-buck. At the intersection on each side is a spring with a scale and an index. By approximation of the two bars we get a measure of the force of the muscles employed in pressing them together. By this instrument we can measure the strength of the foot by placing it on the floor and pressing the uppermost side. In the same way the power of the muscles of the leg may be determined. Also, if we place it in the bend of the knee and make the patient bend his leg backwards, we can ascertain the strength of these muscles. In this way we can find if there be any loss of power, or if there be any difference between the two sides. So it may be applied to the bend of the elbow, the axilla, the hand, and other parts of the body. This instrument shows the relative strength of the two limbs, or of analogous parts on the two sides, in a very perfect manner, and was invented by a friend of mine, who is now dead. Almost any part of the body may be thus tested by its means.

If we do not measure the force of the muscles of a patient suffering from brain disease with great care, we cannot tell accurately the degree of paralysis that is present. Therefore, when I say that there are cases of marked destruction of the crus cerebri, or of any other part of the brain, without paralysis, I simply mean that paralysis has not been recognized and recorded. But I believe that there is always some paralysis, which we have not as yet adequate means of determining.

PHOSPHORUS.

By DR. ANTON VON SCHRÖTTER, Master of the Imperial Mint at Vienna.

FEW substances are so calculated to excite our interest from every point of view so decidedly as phosphorus. It relations, especially to the organic world, claim especially our whole attention.

This element, discovered nearly two centuries ago by Brand and afterwards described by Kunkel, has been therefore the subject of many investigations, and yet many of its properties are even yet not satisfactorily understood.

Phosphorus was first obtained from human urine, and a hundred years afterwards it was shown by Gahn to be an essential constituent of bones. From this fact its universal diffusion in nature might have been inferred, but it has been only of late demonstrated that not merely most substances found on the earth's surface contain phosphorus, but that it is present in most springs, in all rivers, in the sea, and even in the atmosphere (Baral), although but in slight traces. In this respect, therefore, phosphorus ranks among the elements necessary for building up the vegetable and animal body, like oxygen, nitrogen, carbon, hydrogen, chlorine, sulphur, iron, calcium, etc.

Let us now, as far as our immediate purpose allows, consider the properties of phosphorus more closely.

The only kind of phosphorus which was known up to 1848, and which exclusively occurred in trade, and is still known as "ordinary," is a yellow translucent, and, when recently prepared and preserved from the action of light, perfectly limpid body, brittle at low temperatures, but assuming at 15° C. the consistence of wax. Notwithstanding this cerous consistence it still possesses a perfectly crystaline texture, as may be readily perceived by exposure for some time to the action of dilute nitric acid, which attacks it slightly, leaving a surface like that exhibited by tin after treatment with a dilute acid. The single crystals obtained from solvents are decidedly octahedra, exactly agreeing in appearance with common phosphorus, which may therefore justly be called the octahedral. Mitscherlich, however, has observed phosphorus crystallized in dodecahedra.

On exposure to a moist atmosphere phosphorus is luminous in the dark in consequence of a very gradual oxidation and formation of phosphorous acid, which gradually passes into the phosphoric. At the same time a small part of the uncombined oxygen is converted into the modification known as ozone.

The phosphoric vapors hereby diffused exert a very poisonous action if inhaled, producing a disease known as phosphorous necrosis, which begins with the disintegration of the jaw-bones and ends with their total destruction, and under which ill fed and scrofulous persons sink with peculiar rapidity. Phosphorus introduced into the stomach acts likewise as a violent poison.

With regard to its chemical behavior phosphorus must be placed in the same group of elements as nitrogen, arsenic, antimony, and perhaps some other of the simple bodies.

If preserved under water and exposed to daylight ordinary phosphorus is covered with a white crust which gradually becomes detached. The nature of this body was for a long time doubtful. Baudrimont, however, has shown that this crust is formed only under access of oxygen, and possesses all the attributes of ordinary phosphorus, whence we can scarcely doubt that it is merely common phosphorus which, assisted by the presence of the water, crumbles away from the sticks corroded by oxygen.

We may here also refer to the long-known, so-called black phosphorus, which according to Thénard, may be obtained by rapidly cooling phosphorus—previously often distilled—an operation which, be it remarked, has never succeeded in in the hands of the writer of this report. According to Blondlot, phosphorus also becomes black when cooled slowly, but it must be perfectly pure and limpid. The black color is said to depend upon a black body, very minute traces of which are mixed with common phosphorus, which is left behind on solution in carbon bisulphide and passes over first on distillation, so that the last drops are colorless. Black phosphorus is rather softer than the ordinary kind, but it is otherwise scarcely distinguishable. The nature of the black substance accompanying ordinary phosphorus, the formation of which is said to be promoted by mercury, though the latter element forms no part of its composition, is as yet unknown. It may be, as Blondlot supposes, a peculiar modification of phosphorus or a mere impurity.

Since 1848 an allotropic modification is met with in commerce under the name of *red*, or preferably, as it is never a pure red and varies in color according to circumstances, *amorphous* phosphorus. This form differs from the octahedral phosphorus in its most important attributes in a degree almost as great as do the allotropic modifications of carbon—soot, graphite, and diamond—among themselves.

Amorphous phosphorus in compact pieces is an opaque reddish brown substance of imperfect metallic lustre, but where recently broken almost of an iron black. It is brittle, easily broken, and exhibits a perfectly conchoidal fracture with sharp edges. Its sp. gr. is 2·105; in hardness it lies between calcareous spar and fluor-spar. The color of the powder, and consequently of the streak, is reddish brown, exactly resembling that of ignited ferric oxide, otherwise known as colcothar.

Amorphous phosphorus is tasteless and inodorous, insoluble in all liquids which dissolve the octahedral variety, and consequently not poisonous. If taken into the stomach in considerable quantity it is excreted unchanged, and resists, therefore, the powerful oxidizing process in the animal body.

It is absolutely incapable of ignition by friction, and is therefore portable without danger. As the lumps, however, generally contain some ordinary phosphorus in small portions they have to be forwarded in water, since they might otherwise take fire if broken or rubbed. But even then the combustion proceeds very slowly. In the form of powder amorphous phosphorus may be conveyed in tin boxes without any danger.

As commonly met with in trade the pulverulent amorphous phosphorus contains likewise small quantities of ordinary phosphorus—from 0·6 per cent. downwards, according to Fresenius. It is therefore slowly oxidized on exposure to the air and has an acid reaction.

It has been also maintained that amorphous phosphorus, even in the absence of any intermixture of the ordinary variety, is slowly oxidized in the air. This is, however, doubtless an error, since the writer has preserved pure amorphous phosphorus for years spread upon paper and freely exposed to the air without any trace of an acid reaction becoming perceptible. It is still, however possible that there are circumstances, not yet ascertained, in which amorphous phosphorus, even in the absence of any admixture of the octahedral kind, may become acidified by the air. Such a behavior, though often occurring, by no means ranks among the normal attributes of this modification of phosphorus.

In addition to ordinary phosphorus and phosphorous acid, the amorphous phosphorus of commerce contains, inclusive of water, 4·622 per cent. of other impurities, amongst which is always found graphite, derived from the iron vessels in which the preparation takes place.

For ignition amorphous phosphorus requires a temperature of at least 240°. In nitric acid it dissolves on account of its state of subdivision, far more readily than the common variety, because the latter, as a fused mass, offers a much smaller extent of surface for the attack of the acid. Chlorine which combines with common phosphorus with ignition has no action upon the amorphous modification. If heated in a rapid current of chlorine it burns with a yellow luminous flame.

The products of the reaction of various substances upon the two modifications of phosphorus are exactly identical, a circumstance not observed in case of other elements occurring in allotropic forms; *e.g.*, carbon, according to the researches of Brodie, Berthelot, and Stingl.

The conversion of common phosphorus into the amorphous state is effected by exposure to light or to the prolonged action of a temperature of 240° to 250°. The transformation may be effected at 215°, but more slowly. At 260° re-conversion begins into ordinary phosphorus, the boiling-point of which, under average pressure, is about 290°. The transition from one allotropic state to the other can be more readily shown in the case of phosphorus than in that of any other element. All that is required is a glass tube closed with mercury and with several bulbs blown on its horizontal limb. Some common phosphorus is placed in the first bulb at the end of the tube, which on the application of heat ignites and consumes all the oxygen contained in the tube. The residue of the phosphorus is driven into the second bulb, converted there by cautious heating into the amorphous variety, and can then again be distilled into the third bulb in the state of ordinary phosphorus.

In 1865 Hittorf, in a very valuable dissertation which essentially enlarged our knowledge of phosphorus, described a substance which he obtained on exposing amorphous phosphorus along with lead to a red heat in an exhausted glass tube. After cooling, black crystaline leaflets of a metallic lustre were found on the surface of the lead, and were regarded by Hittorf as phosphorus in a new allotropic modification, which he designated as the "metallic crystalline." It would be out of place to enter here upon a detailed examination of Hittorf's interesting observations, but mention must be made of the fact that common phosphorus exposed to temperatures exceeding 300° C. in closed vessels, and consequently exposed to considerable pressure, is transformed into the amorphous condition in a few minutes. As during this conversion a notable elevation of temperature takes place, the pressure upon the sides of the apparatus must be very great. Hittorf is of opinion that manufacturers engaged with the preparation of amorphous phosphorus will welcome such an abridgment of the process. The question, however, arises whether, in the treatment of large quantities, difficulties, and even dangers, might not arise far outweighing the economy of time. According to the present method, when the conversion is affected in open iron vessels in which the air finds but limited access, the process is more tedious, but free from all difficulty.

Manufacture of Phosphorus.—The bulk of the phosphorus is still prepared in the manner indicated by Nicolas and Pelletier. From the bone-earth $Ca_3(PO_4)_2$ is obtained the primary phosphate, $CaH_4(PO_4)_2$, by treatment with sulphuric acid. This is converted by heat into calcium metaphosphate [$Ca(PO_3)_2$], and is then mixed with charcoal powder and distilled at a strong red heat. Stoneware tubes are preferable to the retorts formerly in use, and care must be taken to allow the gases to escape unhindered so that there is no pressure to overcome. The importance of this in all cases where it is requisite to catch and condense vapors escaping from ignited earthen apparatus, will appear from the fact that not a trace of carbon bisulphide can be collected if its vapor has to overcome even a very slight pressure in earthenware apparatus.

The purification of crude phosphorus from impurities present in mechanical admixture, such as charcoal, etc., is best effected by forcing it at a slight pressure through leather by means of a Real's press, kept hot.

The residue (regenerated calcium tri-phosphate) is an excellent clarifying agent, especially for glycerin, and is in great request for this purpose.

The conversion of ordinary phosphrous into the amorphous condition is effected in iron boilers heated to 240°, and left open, but so that the air finds scanty admission through a narrow and rather long tube. The danger of explosion is thus obviated and very little phosphorus is burned, since the interchange of air in the boiler takes place very slowly, whilst the phosphorus consumes all oxygen so rapidly that within the boiler scarcely a trace of this gas is present. The amorphous phosphorus thus obtained, and still always retaining some of the ordinary modification, is ground under water, boiled with soda-lye to remove octahedral phosphorus, washed and dried.—*Hoffman's Report.*

ON THE PREPARATION OF DIALYSED IRON.

By E. B. SHUTTLEWORTH.

As there appears every possibility that dialysed iron will become quite popular, at least for a time, a few practical directions, unincumbered by unnecessary facts or speculations, may serve a useful purpose.

Many methods and modifications of methods have been proposed for obtaining the solution for dialysis, and most of them may be followed successfully. The object is to prepare a solution tolerably concentrated, fully saturated with ferric hydrate, and containing as little acid as possible. I shall describe two methods, each of which has its peculiar advantages. Where time is not an object, as far as duration of the process is concerned, and also in point of economy of labor and materials, the first may be adopted. Where it is desirable to produce a solution that may be finished quickly by dialysis, the second process has the advantage, and, taken altogether, I believe it to be the best.

The first consists in adding ammonia to a solution of perchloride of iron so long as the precipitate formed is re-dissolved. A solution is produced which contains ferric hydrate dissolved in ferric chloride, with free chloride of ammonium. Either the *Liq. Ferri Perchlor. fort.* B. P., or the *Liq. Ferri Chloridi*, U. S. P., may be conveniently used, and the liq. ammoniæ, sp. gr. ·959 or ·960, of either pharmacopœia, will be found a convenient strength. It will be remembered that this is made by adding to the strong ammon ia of commerce about twice its bulk of distilled water. If the ammonia be added to the stronger solution of iron. considerable heat is evolved, and on cooling the preparation becomes gelatinized—often so much so that the vessel containing it may be inverted. It is better to avoid this result, and to this end the solution of perchloride must be diluted until of a specific gravity of about 1·300. This degree may be nearly enough approached by diluting two measures of the B. P. liquor with one of water, or adding one measure of water to five of the U. S. P. preparation. This solution will generally remain permanently bright and fluid. The amount of liq. ammon. required will of course vary with the acidity of the perchloride. The liquor ferri B. P. will sometimes bear as much as an equal volume. A gelatinized solution, even when made from the undiluted liquor, will often be fluid when put upon the dialyser; but, as I have said before, it is better to work with bright solutions.

The second method consists in adding to either solution of the perchloride a quantity of recently-precipitated ferric hydrate. Mix any given quantity of the liq. ferri with about five times its bulk of water and add excess of liq. ammon., also diluted with water. I think a more soluble hydrate is produced when the iron is added to the ammonia, as remarked in the case of the hydrate precipitated from the persulphate; but, in order to proceed in this way, it is necessary to know, approximately, the amount of ammonia required. The precipitate should be washed well, by decantation, with several waters, and then thrown upon a filter to drain for a short time. It may then be dissolved, by the aid of a gentle heat, in as much strong liq. ferri as may be required for solution. The exact quantity cannot be stated, but in no case will it exceed the volume of the liquor precipitated, and sometimes only one-fourth of this amount will be necessary. The solution is now ready for dialysis.

With the majority of pharmacists the dialyser will have to be extemporized out of such materials as may be at hand. The hoop may be a bell-jar, an inverted glass funnel, or what is even simpler and handier, made from one of the flat hoops of an ordinary flour barrel. This may be smoothed a little with a knife or sand paper, and made to the required diameter—10 or 12 inches is a convenient size, if much larger the dialytic septum is liable to belly in the center, and thus make the layer of liquid too deep at that point.

Parchment paper is generally used for forming the septum. This is not the paper that stationers in this country generally supply under this name, but a paper made less pervious, and strengthened by being dipped in sulphuric acid. Some of the strong and well-sized papers, as those used for legal documents, may be made to answer. It is absolutely necessary that there be no holes in the septum, and to ascertain this it is best to sponge with water the upper side of the paper, and then carefully examine the other side. If any drops appear the places should be marked and a little white of an egg may be applied, and coagulated by heat, or a drop of collodion or shellac varnish may be put upon the spot. Bladder, previously washed, may be used, and will be found to work well, especially if divested of its outer coat.

The septum should be two or three inches larger than the hoop, and should be secured around it with twine, not bound tightly, and the edge should be allowed to stand up around the hoop, so that if any liquid escapes through the joint or hoop it will be retained by the paper. The dialyser will now resemble a drum or sieve, and into this the liquid to be dialysed is poured to a depth of, at most, half an inch. It is then floated on the surface of some distilled water contained in a suitable vessel. If the hoop be of some heavy material it must be supported so that the septum is but barely below the level of the water.

The time required for dialysing either of the solutions whose preparation has been described will vary with the nature of the septum, its extent of surface, the depth of liquid, the frequency of changing the water beneath, temperature, and other conditions which need not be enumerated. If everything works well, and the water is changed daily, the process will be finished in one or two weeks. Distilled water is always preferable, and indeed necessary, especially for the first two or three days. Clean rain-water is the best substitute. The process may be said to be complete when the water no longer shows traces of chlorides, and the preparation becomes nearly tasteless, or at least not ferruginous.

A pig's bladder, completely filled with the iron solution, securely tied, and immersed in water, frequently changed, answers well for making this preparation. The process requires a longer time than with a carefully-regulated and properly-conducted dialysis, but it entails considerable less trouble. When I first tried this plan I was not aware that Professor Dragendorff, of Russia, had, some five years ago, suggested its application to dialysed iron. I can, however, corroborate all that he says. I may also mention that I think it an advantage to procure the bladder perfectly fresh, as it is then easily cleansed by pure water, and alkaline lye need not be used. Great care is necessary in tying the neck carefully. This can be best accomplished by a few turns of iron wire. Above this may be secured a piece of twine to suspend the bladder by means of a stick or rod, placed on the edge of the vessel containing the water. The bladder should be perfectly full and immersed altogether in water. The attraction of the solution for the water is so great that considerable pressure is manifested, and should any weak parts or holes be in the bladder the liquid will be forced out, water will take its place, and failure result.

As to the strength of the dialyzed solution I can say nothing, except that with care, and by using the solutions above mentioned, it may be kept over 5 per cent.—the quantity of oxide which appears to have been chosen as the standard. One hundred grains of the liquor should be placed in a tared capsule, and evaporated to dryness. The residue should weigh about 5 grains; if more, distilled water must be added in the calculated proportion; if less, the solution may be placed in a warm and dry place until reduced to the proper volume. If much heat is employed, and often in any case, the oxychloride of iron will be deposited as nor maloxide, and the preparation will be spoiled. The evaporation of the solution may, as a rule, be considered a very unsatisfactory process, and every care should be taken to render it unnecessary.—*Can. Pharm. Journ.*

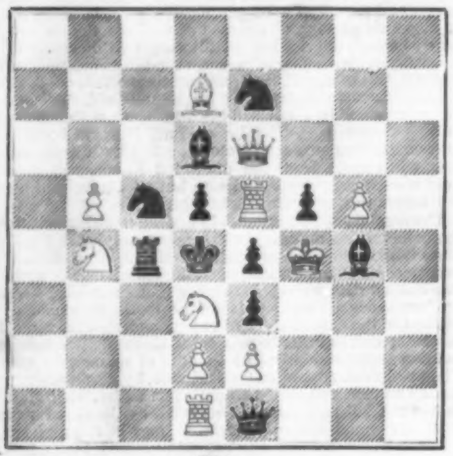
M. E. A. AMAGAT recently described his investigations on the compressibility of volatile liquids, when the liquid state was maintained by pressure at a temperature higher than their boiling point. The pressures were carried as high as thirty-nine atmospheres.

Scientific American Chess Record.

[All contributions intended for this department, may be addressed to Samuel Loyd, Elizabeth, N. J.]

Problem No. 39.—"Faith."—By C. A. Gilberg.

Black.

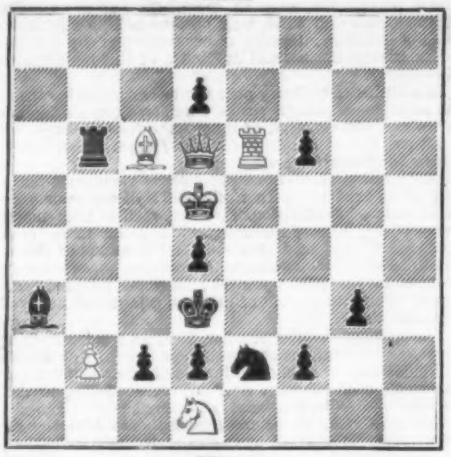


White.

Either to play and mate, or self-mate, in two moves.

Problem No. 40.—"Hope"—By C. A. Gilberg.

Black.

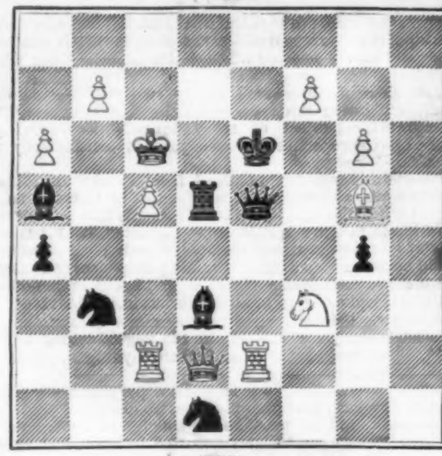


White.

Either to play and mate, or self-mate, in two moves.

Problem No. 41.—"Charity."—By C. A. Gilberg.

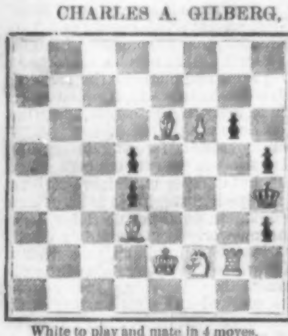
Black.



White.

Either to play and mate, or self-mate, in two moves.

CHARLES A. GILBERG, OF BROOKLYN.



White to play and mate in 4 moves.
By J. N. Babson.

UR gallery for this week contains a most faithful portrait of Mr. Chas. A. Gilberg, the author of the Christmas problems which we have selected as appropriate to the season in preference to his regular compositions, which are too well known to require an extended eulogium at our hands.

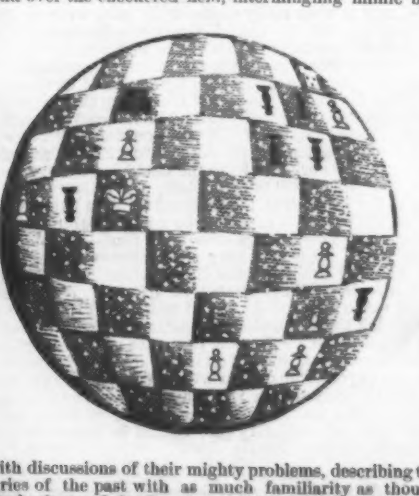
Mr. Gilberg is one of our veteran American problemists, and is one of the few who is recognized the world over as belonging to the foremost ranks of modern composers. His stratagems are distinguished as well for brilliancy as artistic finish, and are not only strikingly original, but convey some pretty idea that repays the solver for his pains. Of course, he prefers problems in few moves, and has but seldom exceeded the reasonable limits of five moves; yet he is famous as a solver, and fearlessly attacks the most lengthy and complicated stratagems that are submitted to him. He is not only an able and scientific critic on all problematical questions, but is one who is not apt to give a careless or mistaken opinion, for which reason he is a favorite umpire with our problemists.

Mr. Gilberg is a liberal and enthusiastic patron of chess, and would rank as one of our strongest players. He seldom participates in active play, however, but seems to have satisfied himself with accumulating one of the largest and most valuable collections of chess works ever brought together, which we will remark, *en passant*, has been most kindly placed at our disposal, to make our Chess Record complete.

In conclusion, allow us to express our regrets that one of Mr. Gilberg's competing problems in the Centennial Tournament was found to be incorrect, which little slip prevented him from receiving the second prize. As the present issue would hardly be complete without a Christmas story, allow us to give one in which we introduce a problem in which we take considerable pride as being the most scientific position we have ever attempted.

CHESS SPECTRUM ANALYSIS.

Profs. Proctor and Tyndall are both enthusiastic chess players, and many are the pleasant hours I have known them to spend over the checkered field, intermingling mimic bat-



tles with discussions of their mighty problems, describing the mysteries of the past with as much familiarity as though they had witnessed the Creation and lived through the long ages of Chaos and Formation, and discussing the climate, mineral products and prosperity of fall crops, in worlds billions of miles beyond all known distance, with the easy assurance of speculators in Western lands.

I had long ceased to be surprised at their Theories; in fact, nothing that either of them could say or do would affect my equilibrium, so I was in no way astonished by the abrupt entrance of Tyndall into my room one morning, exclaiming:

"Loyd, you have often heard of *The Problem of the Sun!*"

"Yes; but I can't say that I ——"

"Well, I was thinking of those lines wherein Dante says the spots of the sun are but the squares of a chess board, and as we were experimenting with a new sun spectrum, it de-

Yours truly,
Chas. A. Gilberg.

veloped a kind of leathery smell, suggestive of our old chess board. We followed the idea up, and, by George! the old boy was right! It *is* a chess board, and there is some kind of a position on it, as an examination of the spectrum will show."

"You see there is a simple, although somewhat pretty, mate in three moves." (Which we leave our solvers to discover.)

This I at first thought to be all there was to the position, but Proc.'s spectrum analysis shows the entire moves of the past, and proves how the position must have occurred, and demonstrates the certainty of a MATE IN ONE MOVE.

In the first place, by applying the test, we show the fate of the white forces in the following manner:

The black pawns on knight's 3d and bishop's 3d have, evidently, captured two of the opposing forces—we can prove that the pawn on bishop's 3d could have captured no other piece than a white bishop; the one on knight's 3d we will suppose to have taken a knight. The black pawn on rook's 6th could only arrive at its present position by four diagonal moves from queen's 2d to king's 3d, to bishop's 4th, to knight's 5th, to rook's 6th, necessitating the capture of four more white pieces, which must have been the queen, two rooks and a knight, as the white king's bishop, it is evident, was never moved from bishop's square, having died at his post. This shows how white must have lost his entire force —queen, rooks, bishops and knights. The rook on rook's 8th, therefore, must have been a pawn, and must have been the queen's knight's pawn, which advanced and captured black's rook's pawn, made a rook on rook's 8th, and moved across to its present position.

We will now proceed to analyze the position and fate of the black forces, which can be proven as follows:

The white pawns on knight's 2d and 3d were, evidently, rook's and bishop's pawns. The one on knight's 3d captured the queen; the one on knight's 4th could have captured no other piece than a bishop. The pawn on rook's 7th must have reached its present position by a diagonal series of captures, proceeding from queen's 2d to king's 3d, to bishop's 4th, to knight's 5th, to rook's 6th, and then advanced one square to its present position, which demonstrates the fate of four more pieces. Having shown, therefore, the capture of queen, two rooks, one bishop, two knights and queen's rook's pawn, we have merely to account for the loss of black's queen's bishop's pawn, which, it can be proven, was captured on its original file, but it is only necessary to demonstrate that it was not taken by the white pawn on bishop's 6th. This could not have been the case, because, if the white pawn came from queen's 5th (or knight's 7th) it must have been a doubled pawn, as the rook and pawn on rook's 7th and 8th, it has been shown, were originally queen's pawn and queen's knight's pawn; therefore, the pawn could only have arrived at queen's 5th or knight's 5th by moving from queen's bishop's file, which would necessitate the capture of another piece, whereas it has been shown that black's entire forces were captured in other ways, and there was no pawn or piece to spare to allow of these two extra captures.

If it is now white's move, it is evident that black has just played, and the point is to demonstrate what that move must have been.

The king could not have moved from bishop's or queen's square without capturing bishop or knight, with which white has just uncovered check from rook. This could not be, as white had no such piece to sacrifice.

The king could not have moved from knight's 2d or queen's 2d, unless the white pawn had just made a capture, which we have shown to be impossible.

The pawn on rook's 6th could not have moved last, as it has been shown that it arrived, by a capture, from knight's 5th.

The pawn at bishop's 3d could not have moved last, else the king's bishop could not have been played from bishop's square.

The bishop could not have been played from rook's 3d, as it would have placed the white king in check.

The pawn on knight's 4th could not have been advanced one square as white king would have been in check; nor could it have come from rook's 3d, as that would necessitate another impossible capture. The only possible move, therefore, as can be demonstrated and proven by the entire game, must have been P to Kt 4—in which case white can mate in one move by Q x P *en passant*.

"And you see," continued the Professor, as he carefully replaced his spectacles, "if is a strong point in favor of Huxley's reply to Dr Forbes' remark in his History of Chess. You know that Huxley argues that if the combinations of chess are inexhaustible, then anything that is endless could have had no beginning, and that chess, like steam, electricity, etc., may have been discovered but was never invented, and that, instead of bothering their heads to discover the date of the origin of chess, it is as plain as the movements of the heavenly bodies, that chess was one of the original developments from which sprang moving and breathing genius, with its kings, queens, bishops, knights, castles, peasants, and such other features of the age as are fast becoming obsolete.

"It would take but little argument to show that a mere oversight of Guttenburg's proof-reader made the world believe the moon was composed of cheese instead of chess."

SOLUTIONS TO PROBLEMS.

No. 33.—By R. B. Wormald.

WHITE.	BLACK.
1. R to K R 6	1. Any move
2. Mates accordingly.	

No. 34.—By C. M. Baxter.

WHITE.	BLACK.
1. B to Q R 8	1. Any move
2. Mates accordingly.	

Letter "B."—By J. N. Babson.

WHITE.	BLACK.
(White to mate.)	
1. Kt to R 5 ch	1. K x P
2. Q to R 3 mate.	
(White to self-mate.)	
1. R x P ch	1. P x R
2. B to Q 3 ch	2. Q x B mate.
BLACK.	WHITE.
(Black to mate.)	
1. Q x R ch	1. P x Q
2. Kt to Kt 6 mate.	
(Black to self-mate.)	
1. R to K 7 ch	1. R or Q intp.
2. Q to Q 6 ch	2. B x Q mate.

The Scientific American Supplement. Index for Vol. 4.

JULY—DECEMBER, 1877.

The * indicates that the Article is illustrated by Engravings.